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ABSTRACT

This conference focused on the effective use of technology in schools by examining the following issues: (1) What value-added does technology bring to schools? (2) What does it take at the system level to enable learners, teachers, administrators, and communities to use technology effectively? (3) What assessment strategies and designs are currently being used to capture the value-added technology brings to schools? and (4) How do schools need to evolve in order to become a high-tech, high-performance enterprise that builds the capacity of learners, teachers, administrators, and community members to use the emerging technologies wisely and effectively? The first two sections present the conference agenda and information on featured speakers. The third section contains profiles of Spotlight Schools. The fourth section provides summaries of demonstration projects, and the fifth section describes several evaluation tools. The sixth section contains the following conference white papers: "Expanding International Education through the Internet: No Longer Limited to the Global Studies and Foreign Language Curriculum" (Edwin H. Gragert); "Assessing the Role of Educational Technology in the Teaching and Learning Process: A Learner-Centered Perspective" (Barbara L. McCombs); "Developing Assessments for Tomorrow's Classrooms" (Barbara Means, Bill Penuel, and Edys Quellmalz); "New Designs for Connected Teaching and Learning" (Margaret Riel); "A Lesson from Richard Nixon: Observations about Technology Policy and Practice in Education (Saul Rockman); "It's Time To Upgrade: Tests and Administration Procedures for the New Millennium" (Michael Russell); and "Ice Machines, Steamboats, and Education: Structural Change and Educational Technologies" (Robert Tinker). The seventh section is a report on the conference entitled "Measuring Impacts and Shaping the Future," that addresses several critical questions. The final section contains the full text or outlines of several conference presentations. (MES)

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ED 452 828

The Secretary's Conference on Educational Technology, 2000: Measuring Impacts and Shaping the Future. [Proceedings] (Alexandria, Virginia, September 11-12, 2000)

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DEPARTMENT OF EDUCATION UNITED STATES OF AMERICA

Conference Agenda

Featured Speakers

Spotlight Schools

Demonstration Projects

Evaluation Tools

Conference White Papers

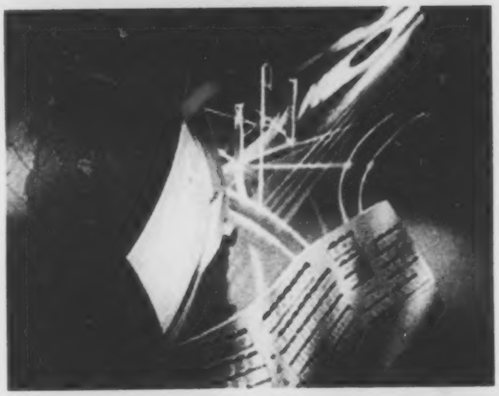
The Secretary's Conference on Educational Technology

MEASURING IMPACTS AND SHAPING THE FUTURE

The Secretary's Conference on Educational Technology 2000 focused on the effective use of technology in schools by examining the following issues:

- What value-added does technology bring to schools?
- What does it "take" at the system level to enable learners, teachers, administrators and communities to use technology effectively?
- What assessment strategies and designs are currently being used to capture the value-added technology brings to schools?
- How do schools need to evolve in order to become a high-tech, high-performance enterprise that builds the capacity of learners, teachers, administrators and community members to use these emerging technologies wisely and effectively?

Final Conference Report



Video on Demand for the 2000 Secretary's Conference on Educational Technology

Presentations from Key Speakers

ED HOME TECHNOLOGY

This page last modified January 12, 2001 (bay).

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The Secretary's Conference on Educational Technology 2000

AGENDA

Hilton Alexandria Mark Hotel
September 11th - Monday
Day One

Break-Out Session Discussion Template for Day One

8:30am - 10:30am ***Opening Session***
Plaza Ballroom

Video
Teaching and Learning in the Digital Age
George Lucas Educational Foundation

Conference Orientation
Diane Reed, Technology Teacher in Residence
U.S. Department of Education

Welcome
Linda Roberts, Director of the Office of Educational Technology
U.S. Department of Education

Secretary's Address
Richard W. Riley, Secretary of Education
U.S. Department of Education

Keynote Address
Information Technology and Information Literacy
Eric Benhamou, Chairman and Chief Executive Officer
3Com Corporation

10:45am - 12:30pm ***Breakout Sessions***

Spotlight Schools Discussion
Measuring the Impact of Technology
Spotlight Schools and noted researchers and evaluators will discuss, *What is the "value-added" that you bring to students through technology? How are you assessing this?* See the Breakout Matrix for the spotlight school assignments and rooms. All conference participants are invited to join the discussions. The Day One Template will guide the discussions.

or

Outstanding Technology Demonstration Projects
Outstanding projects on display.
Terrace Room

12:30pm - 2:00pm ***Luncheon***

Multimedia Presentation
Teacher Florence McGinn and students
Hunterdon Central Regional High School
Flemington, NJ

Luncheon Address
Renaissance 2000
David Thornburg
President, The Thornburg Center

2:00pm - 3:30pm ***Plenary Session***
Plaza Ballroom

Measuring our Progress with Real Tools: Why does technology work in some schools and not in others?

Moderator Margaret Honey
Director, Center for Children and Technology

	Panel	**enGauge** Presented by Cheryl Lemke CEO, Metiri Group
		Four Cornerstones Presented by Bernajean Porter Education Technology Planners
		Profiler Presented by Jim Nazworthy High Plains R*TEC
		CEO Forum Star Chart Presented by Cheryl Williams National School Board Association
3:30pm - 4:30pm	***Statewide Data Collections Session***	
	Moderator	Michael Cohen Assistant Secretary, Office of Elementary and Secondary Education U.S. Department of Education
	Panel	**Maryland** Barbara Reeves State Technology Director
		Ohio Tim Best State Technology Director
	Question & Answer Session Featured States	
5:30pm - 7:30pm	***Reception and Exhibits***	

Conference participants are encouraged to visit the exhibit area to talk with some of the most outstanding technology projects in the country.

Members of Congress Invited.

Hilton Alexandria Mark Hotel
September 12th - Tuesday
Day Two

Break-Out Session Discussion Template for Day Two

7:30am - 8:30am ***Continental Breakfast and Exhibits***

8:30am - 10:00am ***Plenary Session***
Plaza Ballroom

Higher Education and K-12 Partnerships: Technical Assistance for Evaluating the Effectiveness of Technology

Moderator
Cheryl Lemke
CEO, Metiri Group

Panel
Elliot Soloway
Professor, University of Michigan

Cathie Norris
Professor, University of North Texas

Ann Mastergeorge
Professor, UCLA

Steve Cowdrey
Director of Technology
Cherry Creek, Colorado

Charol Shakeshaft
Professor, Hofstra University

Liz Glowa
Director of Technology
Montgomery County Public Schools, Maryland

Walter Heineke
Assistant Professor
University of Virginia

Laura Blasi
Fellow
University of Virginia

Sarah Skerker
Mantua Elementary
Fairfax County, Virginia

Question and Answer Session
Panelists

10:15am - 12:30pm	***Breakout Sessions***

Spotlight Schools Discussion
Measuring the Impact of Technology
Spotlight Schools and noted researchers and evaluators will discuss, *What conditions are critical to the effective use of technolgy in schools?* See the Breakout Matrix for the spotlight school assignments and rooms. All conference participants are invited to join the discussions. The Day Two Template will guide the discussions.

or

Outstanding Technology Demonstration Projects
Outstanding projects on display.
Terrace Room

Breakout Session
State TLCF Coordinators
Lakeside 1

12:30pm - 2:00pm	***Luncheon***

Multimedia Presentation
Portage Path School of Technology, Akron, Ohio
Mott Hall School, New York City Community District #6

Announcement of Exemplary and Promising Educational Technology Programs

2:00pm - 3:30pm	***Plenary Session***

International Panel

Global Connections through Technology

Moderator	Keith Geiger Deputy Assistant Secretary for Academic Programs U.S. Department of State
Panel	Robert McNergney Professor, University of Virginia
	Ed Gragert Director, International Education and Resource Network
	Kristi Franz Teacher, International Education and Resource Network
	Kevin Warner Worldwide Education, Cisco Systems
	Enrique Hinostroza Worldlinks, Chile

3:30pm - 4:40pm ***Closing Session***

Developing Assessments for Tomorrow's Classrooms

Moderator
Linda Roberts
Director, Office of Educational Technology
U.S. Department of Education

Panel
Barbara Means
Co-Director, Center For Technology In Learning
SRI International

Bill Penuel
Research Social Scientist
SRI International

Bob Tinker
Concord Consortium
"Ice machines, Steamboats, and Education: Structural Changes Induced by Technology"

4:45pm - 5:00pm ***Closing Multi-Media Presentation***

The PT3/Class Act Project for Tomorrow's Teachers
Bemidji State University
Bemidji, Minnesota

Outstanding Technology Demonstration Projects

Exhibit Area
Day One and Day Two

Mantua: A Basic School Powered By Technology
The Vision Continues
Fairfax County Public Schools
Fairfax, Virginia
Technology integration, performance assessments, and student demonstrations.

One Sky, Many Voices
University of Michigan and Detroit Public Schools
Detroit, Michigan
Multiple school sites work together to study current atmospheric science events through technology.
National Science Foundation

The Cognitive Tutor Curriculum
Fox Chapel High School and Carnegie Learning
Pittsburgh, Pennsylvania
Using integrated print and software curricula to increase test scores.

Generation www.Y: Students as Change Agents
Olympia School District
Olympia, Washington
Students and teachers working together to create curriculum-based, technology infused projects and lesson plans.
Technology Innovation Challenge Grant

The WEB Project
Putney, Vermont
Organizations, businesses and schools working together to reform schools through technology. Encouraging student inquiry, presenting student work and virtual faculty rooms.
Technology Innovation Challenge Grant

Knower's Ark...Creating Spielbergs in Vermont
South Burlington High School
South Burlington, Vermont
Student-supported and operated graphics lab that encourages community participation.

Montgomery County Public Schools' Core Staff Development Models
Montgomery County, Maryland
Integrating technology into early childhood reading and language arts instruction.
National Science Foundation

The C5 Project: Children Connecting Classrooms Community Curriculum
Portage Path School
Akron, Ohio
School partnered with Time Warner for high speed internet access both at school and in children's homes.

The IMMEX Project at UCLA: Tracing the Development, Transfer and Retention of Problem-Solving Skills
Los Angeles, California
Implementing multimedia problem-solving software in many disciplines and levels of education.

International Education and Resource Network (I*EARN) In the Primary Classroom: Launching Literacy Essential
Sunnyside Elementary School
Pullman, Washington
A community of schools in over 60 countries using telecommunications for curricular projects with local and global impact.

Palm-Based PicoMaps to Internet-Based Snapshot Surveys: Leveraging Emerging Technologies for Learning and Teaching
University of Michigan and University of North Texas
Developing inquiry pedagogy, where students investigate questions of their own design.

The Fulbright Memorial Fund Master Teacher Program
Tokyo, Japan
International exchange for teachers and administrators.

ISTE National Technology Standards for Teachers: Preparing Tomorrow's Teachers to Use Technology Grant
Establishing performance-based standards and assessments for improving technology competence in preservice education.

The Challenge 2000 Multimedia Project
Students use real-world information and research methods to design multimedia presentations. Curriculum development and professional development.
Technology Innovation Challenge Grant

Modeling Instruction in High School Physics
University of Arizona
Tucson, Arizona
Training and supporting physics teachers as local experts in science teaching with technology.

Middle School Mathematics through Applications Project
Curriculum and software to make math relevant and accessible to students.

Class Act Project: Preparing Tomorrow's Teachers to Use Technology Grant
Bemidiji State University
Bemidiji, Minnesota
Training teachers for technical proficiency.

Universal Design for Learning: Preparing Media for Supported Learning
Peabody, Massachusetts
Making text-based materials accessible to all users through the addition of spoken voice, visual highlighting and other methods.

ED HOME EDTECH CONFERENCE 2000 *This page last modified September 8, 2000 (bay).*

The Secretary's Conference on Educational Technology 2000

Day One Template: Documenting Key Ideas from the Sessions and Your Discussions

Breakout Session Questions:

1. What constitutes effective use of technology in learning? What value(s) does technology bring to learning?
2. Will we recognize effective uses of technology when we see them?
3. What can we learn from business and industry?
4. What uses of learning technology does the public value?
5. How can we successfully gauge and report progress in using technology successfully at the student performance levels?

I. Value-Added through Technology

For each of the spotlight schools, identify the value-added they bring to students through technology:

Spotlight Schools: Check all that apply for each spotlight school. Note context (e.g., content area, grade level, impetus)	**Value-Added:** Source: enGauge, NCREL

A	B	C	**Accelerate Learning: Ensure that Students Achieve the Academic Standards**
			• Basic Literacy
			• New Ways to Learn Content
			• Other:

A	B	C	**Enrich and Extend Learning: Deepen Students' Understanding of the Academic Standards**
			• Real-World Context to the Academics
			• Higher-Order, Critical Thinking and Problem Solving
			• Information Literacy
			• Other:

A	B	C	**Achieve 21st Century Learning: Add Digital Age Skills and Proficiencies to the Academic Standards**
			• Visual Literacy
			• Engagement, Motivation and Independence
			• Ecommunication
			• Collaboration and Teaming
			• Productivity and Creativity

			- **Other:**

II. Measured By What Metrics-What Benchmarks?
Is the value-added of technology being measured? Are the new skills currently measured? If not, how should it/they be measured? What are the benchmarks-how do you know what is 'good enough?'

Value-Added through Technology Source: enGauge, NCREL	**Metrics: What is?** What are schools and others in your session currently doing to measure the value technology brings to learning in these categories?	**Metrics: What Should Be?** What new dimensions to assessment and evaluation of the value technology brings to learning were discussed by your group?
Accelerate Learning: Ensure that Students Achieve the Academic Standards • Basic Literacy • New Ways to Learn Content • Other		
Enrich and Extend Learning: Deepen Students' Understanding of the Academic Standards • Real-World Context to the Academics • Higher-Order, Critical Thinking and Problem Solving • Information Literacy • Other:		

Achieve 21st Century Learning: Add Digital Age Skills and Proficiencies to the Academic Standards ● Visual Literacy ● Engagement, Motivation and Independence ● Ecommunication ● Collaboration and Teaming ● Productivity and Creativity ● Other:		

Source: enGauge by NCREL

III. In Summary:

PRIORITIES:

Your Group's Top three Priorities for Value Added Technology Brings to Learning	In your spotlight schools, which students, if any, are impacted the most from each "value add?" ?	Is the "value add" being assessed? If so, describe-noting at which level the assessments take place (local, district, state, national).
1.		
2.		
3.		

Comments:

ISSUES:

What critical issues have been raised in your group discussions regarding the effective uses of technology and how such uses should be measured?

What are the barriers to scaling these effective uses (value adds from technology) to all students in all of public education?

What have you learned from business and industry through your discussion about parallel experiences in bringing effective and productive uses of technology into the world of work?

HOME EDTECH CONFERENCE 2000 *This page last modified August 24, 2000 (bay).*

The Secretary's Conference on Educational Technology 2000

Day Two Template:
Documenting Key Ideas from the Sessions and Discussions

Breakout Session Questions:

1. How can we successfully gauge and report progress in using technology successfully at the educator proficiency and system capacity levels-as well as at the student performance level?
2. What conditions must be in place in schools to ensure effective use?
3. What is the policy road map that would build the capacity of communities and schools to move toward more effective uses of technology in schools?

I. What attributes and characteristics impact the effective uses of technology in schools?

Conditions Critical to the Effective use of Technology in Schools Sources: Sources: CEO Forum, enGauge, Profiler and Four Cornerstones	**What helps?** What are the key factors that contribute to the effective uses of technology in schools?	**What hinders?** What are the most serious barriers to the effective uses of technology in schools?	**How to track progress?** What systems are in place for tracking progress at the school, district and state levels?
Access			
Vision/Philosophy (Approaches to learning, student roles in learning, equity, etc.)			
Effective Practice School Culture, Range of Use, Content, Instruction & Assessment			
Teacher Proficiency			
Administrator Proficiency			

Systems Thinking-Leadership Engagement of Staff, Support, Time, Resources, $$$, Facilitating Change			
Systems Thinking-Professional Development			
Systems Thinking-Community (Local and Global)			
Others			

II. A SUMMARY of the ESSENTIAL CONDITIONS:
List your group's top five conditions essential for a high-performance, high-tech school? What should decision makers pay attention to if they want to get learning results from technology? How does the answer to that question change in accordance with the school's/district's vision of technology's uses in learning?

III. A SUMMARY of the BARRIERS:
Your group's five most serious barriers to significant, effective uses of technology for learning, in priority order. Again, is that list contingent upon what the school is trying to accomplish?

IV. ISSUES:
What critical issues have been raised in your group discussions regarding the conditions essential to the effective uses of technology-and how progress should be tracked at the system levels?

V. REPORTING PROGRESS:

How can educators more effectively report progress at the student performance, educator and systems levels to inform policy and decision makers?

VI. POLICY ROAD MAP

What actions by policy makers would contribute the most to the effective uses of technology in learning?

VII. LESSONS FROM BUSINESS AND INDUSTRY

What have you learned from business and industry through your discussion about parallel experiences in bringing effective and productive uses of technology into the world of work?

This page last modified August 24, 2000 (bay).

DEPARTMENT OF EDUCATION · UNITED STATES OF AMERICA

The Secretary's Conference on Educational Technology 2000

PRESENTERS

Eric Benhamou
Chairman and Chief Executive Officer
3Com Corporation

Eric Benhamou was named CEO of 3Com Corporation in September 1990; previously, he held a variety of senior management positions in engineering, operations, and management. From 1993 to 1997, Benhamou served on the Board of Directors of Smart Valley Inc., a nonprofit consortium seeking to revitalize the Silicon Valley economy through advanced telecommunications and networking technologies. Benhamou chaired Smart Valley's telecommuting effort. In 1997, Bill Clinton appointed Benhamou to the President's Information Technology Advisory Committee, which advises the President on research and development focal points of federal programs to maintain United States leadership in advanced computing and communications technologies and their applications. Benhamou currently serves as chairman of the Board of Directors of Palm, Inc. He serves as Chairman of the National Advisory Board for Western Governors University, a virtual university using advanced networking technologies to deliver technology-based distance-education. He also serves on the Board of Directors for Cypress Semiconductor and Legato, as well as the Stanford University School of Engineering board of advisors. Benhamou holds an honorary doctoral degree from Ben Gurion University of the Negev, a master of science degree in electrical engineering from Stanford University, and a Diplôme d'Ingénieur from Ecole Nationale Supérieure d'Arts et Métiers, Paris.

Tim Best
State Technology Director, OH

Tim Best is the program director for the state of Ohio's Ohio SchoolNet Commission. In this capacity, Dr. Best designs and coordinates professional development opportunities that focus on technology and learning for Ohio teachers. Prior to his work in state government, he was executive director of the Center for Leadership in Education, a Cleveland-based foundation involved in school change. Dr. Best has also served as senior researcher with the Coalition of Essential Schools at Brown University and as a systems designer for Fitch, Inc., a London-based design consultancy.

Steve Cowdrey
Cherry Creek School District, CO

Mr. Cowdrey a strong mix of education, business, and management experience. His professional career includes upper level management positions in both educational and business settings. Currently, he holds the position of Director of Educational Technology and Media at Cherry Creek Schools in Denver, the third largest school district in the State of Colorado. His responsibilities include long-range planning, professional development (including an in-district Technology Masters Degree program), program coordination, and curriculum development integrating technology. He also directs the media program and the Student Achievement Resource Center, which houses Staff Development, Media Production, the Professional Library, Bibliographic Services, and the Consolidated Video Library. Since Mr. Cowdrey joined Cherry Creek, the district has received honors from The National School Boards Association (site visit and Video Salute), Apple Computer (featured in Five Step Forward: Professional Development satellite broadcast and on Apple's Teaching Learning and Technology CD), and the U.S. Department of Education (represented Colorado at the Secretary's National Educational Technology Conference). Prior to joining Cherry Creek Schools, he served as a full-time consultant and traveled nation-wide providing technology planning and professional development for schools and school districts. He has also served as Technology Coordinator for Colorado Springs Public Schools and held positions in the district as Teacher, Instructional Supervisor, and Science Supervisor. Mr. Cowdrey's experience outside education includes positions as Vice President of a local computing firm, Media Production Manager for an advertising agency, and Minister of Youth and Education in a local church. He holds a Certificate of Advanced Graduate Study in Educational Technology, a Masters of Arts in Teaching, a Masters of Religious Education, and a Bachelor of Arts in Psychology.

Kristi Rennebohm Franz
International Education and Resource Network

Kristi Rennebohm Franz is a primary multiage classroom teacher of 6,7,8 year olds at Sunnyside Elementary School in Pullman, Washington. Since 1993, she has been using telecommunications with her young students to develop their literacy, science, social studies, art, world language, multicultural, geography and math understandings. Her first and second graders author their classroom email messages, website, edit and use digital images and edited video tapes as well as use videoconferencing from their school to share their learning across curricular topics with local to global peers. They assume new technologies as a way to learn! As a Lead Teacher on the International Education and Resource Network since 1993, Kristi has designed and coordinated online curricular classroom service learning collaborations for children around the world such as the Global Art Projects (on topics of Family, Caring, Peacefulness, and Habitats), Quilt Math as part of Connecting Math to our World Project, Water Habitat Project, Comfort Quilt Project, Dr. Martin Luther King, Jr. Peace and Friendship Project and Family Elders Project. These projects have received local to global recognition. She has created "Launching Literacy Essential Learnings Through Local to Global Communications" and "The WRITE to Care Framework" as curricular models of meaningful uses of technology in the primary classroom.

Keith Geiger
U. S. Department of State

Keith Geiger was named by President Bill Clinton as Director of the U.S. Information Agency's Office of Academic Programs in 1997. In 1999, USIA became part of the US Department of State, where Mr. Geiger now serves as Deputy Assistant Secretary for Academic Programs. He directs the Fulbright Program, the U.S. government's premier international educational exchange program. Mr. Geiger also oversees the English language training programs abroad and foreign student advising programs. Mr. Geiger has a 35 year distinguished career in education before joining the U.S. Department of State. He served as President of the National Educational Association, (NEA), from 1989-1996. He was appointed by Presidents Reagan, Bush and Clinton to national boards and commissions on the future of education and teaching, and was a member of the executive board of Education International, the international teachers' union. Mr. Geiger was born in Michigan, and began his career as a high school mathematics and science teacher. He received his Bachelor's degree from Asbury College in Kentucky and an MA from Peabody College in Tennessee.

Liz Glowa
Montgomery County Public Schools, MD

Dr. Glowa has a strong mix of elementary and secondary regular and special education experience. Her professional career includes working as a teacher, school administrator, and district level administrator. Recently, she became the special assistant to the Chief Information Officer in the Office of Global Access Technology for Montgomery County Public Schools, one of the largest and most diverse school districts in the nation. Her work is focused on special projects including distance education, community outreach and partnerships, grants, and representing the needs of schools and students on the leadership team within the Office of Global Access Technology. She serves as the principal investigator on the Maryland Technology Consortium, a Federal Innovation Challenge grant. The Maryland Technology Consortium is focused on identifying, developing, and assessing highly effective models of staff development for training teachers to integrate technology into curriculum at the secondary level. Primary partners in this grant include the Maryland State Department of Education, Prince George's and Baltimore Counties, Johns Hopkins and Towson Universities, Marco International, Microsoft, and Apple Computers. Previously, she held the position of Director of Instructional Technology in Montgomery County Public Schools (MCPS). MCPS has 189 schools spread throughout an urban-to-rural landscape of more than 500 square miles. Dr. Glowa's responsibilities included providing leadership in the planning and implementation of the countywide Global Access project, professional development design, delivery and evaluation, and resource development to support the instructional uses of technology. This development has included curriculum revision to reflect technology integration, web sites designed to support teaching and learning for staff and students, and community, and grants. The Early Childhood Technology Literacy Project, a Federal Literacy Challenge grant, was the top winner in the Education and Academia category of the 2000 Computerworld Smithsonian Awards. This award recognizes innovative applications of technology that benefit society. Dr. Glowa has presented at national conferences including NSBA Technology and Learning and the U.S. Department of Education Secretary's National Educational Technology Conference. She has served on county, state, and national task forces focused on distance education and evaluating technology implementation.

Ed Gragert
International Education and Resource Network

Dr. Edwin H. Gragert is Director of I*EARN-USA. Since it's creation in 1988, I*EARN has expanded significantly, now linking students and teachers in 92 countries to enable them to collaborate on projects that both enhance learning and improve the quality of life on the planet. From 1979-90, he was the Executive Director of ICYE-US, a youth exchange program with both high school and community service volunteer exchanges among 30 countries. He worked for the International Relations Committee of the U.S. House of Representatives in 1978, investigating US-Korean relations. Dr. Gragert received his BA in Japanese political science from the University of Washington (Seattle) and MA in Korean History at Columbia University. His Ph.D. at Columbia University was in Japanese history, focusing on landownership changes brought about by Japanese colonial administration in the early 20th century. His book, "Landownership Under Colonial Rule: Korea's Japanese Experience," was published by Columbia and the University of Hawaii in 1994.

Enrique Hinostroza
Worldlinks, Chile

Dr Hinostroza has professional qualifications in Industrial Engineering (1998), a Master degree in Computer Science (1990) and a Ph.D. in Information Technology in Education (1999 - Institute of Education, University of London). His research interests are related to the design and use of ICT in education. Since 1992 he has been working as part of the core team of the Chilean national project 'Enlaces'.

Cheryl Lemke
The Metiri Group

Cheryl Lemke is the CEO of the Metiri Group, a consulting firm based in Los Angeles, California. She is a respected facilitator, currently working with groups such as the Senator Bob Kerrey's Web-based Education Congressional Committee, the CEO Forum and the U.S. Department of Education. Her firm provides services ranging from public policy consultation to school technology audits and online assessment designs. Formerly the Executive Director of the Milken Exchange on Education Technology, Ms. Lemke is a nationally recognized expert in education technology. With more than 20 years experience in public education, she has held positions as the state technology director in Washington State and the Associate Superintendent for Learning Technology for the Illinois State Board of Education.

Ann Mastergeorge
University of California, Los Angeles

Ann Mastergeorge is a senior researcher and project director at CRESST. Dr. Mastergeorge received her Ph.D. in the Graduate School of Education at UCLA in the division of educational psychology and developmental studies. Her areas of expertise are in qualitative methodology and research design, and assessment and evaluation of school reform efforts. Her research interests include sociocultural learning in classroom contexts, understanding problem-solving contexts in school cultures and everyday environments, language and learning development and disability, perceptions of disability in classroom environments, and teacher belief systems in creating learning environments. Projects directed at CRESST include assessments of teachers' understanding and implementation of instructional strategies and accommodations for students with disabilities, evaluating school culture shifts in implementing educational plans for students with disabilities, evaluations of best practices for integrating technology in school environments, assessments of collaborative learning environments in mathematics, and evaluating school reform in schools across the country implementing creative learning communities.

Barbara Means
SRI International

Barbara Means serves as Center co-PI, directs the CILT evaluation component, serves as co-leader for the Assessments for Learning theme team, and is responsible for making SRI's intellectual, organizational, and equipment resources available to the Center. Dr. Means' own research focuses on the development of innovative approaches for evaluating technology-supported education initiatives and the study of collaborative learning over electronic networks. She leads SRI's evaluation of GLOBE (http://www.globe.gov/), a worldwide WWW-based science and education program, and the evaluation of Silicon Valley Challenge 2000, a public-private partnership to support systemic reform and the introduction of technology into 37 schools in 9 districts. She was co-PI on an NSF grant to study how network and collaborative software technology can support learning through interactions with a mentor.

Florence McGinn
Hunterdon Central Regional High School, NJ

Recipient of the Microsoft-sponsored Technology and Learning 1998 United States National Teacher of the Year award, the NJ and United States Eastern Region Teacher of the Year awards, two NJ Best Educational Practices awards, a NJ Association of School Curriculum award, and the 1998 Princeton University Distinguished Secondary School Educator award. Mrs. McGinn is a US Commissioner on the Congressional Commission for Web-based Education. Mrs. McGinn was appointed by US Secretary of Education Richard Riley to that 16 member committee charged by legislation to prepare a report and policy recommendations to Congress and the President. She serves on advisory boards for PBS OnLine, the Milken Foundation, SchoolCity.com, and Technology and Learning magazine. Florence McGinn is presently appointed to advisorships for PBS On-line, the Milken Foundation, Technology and Learning magazine, and SchoolCity. Mrs. McGinn's pilot project work develops through support from AT&T, Johnson & Johnson, Liberty Science Center, Lucent Technology, Bose Corporation, Global Knowledge Exchange, ComWeb, and the Hunterdon Foundation. Electric Soup, her high school's on-line literary magazine, has received a NJ Best Educational Practices award, a NJ Association of School Curriculum award, and been cited as one of NJ's best web sites as well as one of the Ten Best Educational Sites on the Internet. She teaches English and is a Pilot Programs Developer at Hunterdon Central Regional High School in Flemington, New Jersey. She has taught courses on technology-assisted learning at The Academy and the ETTC as well as in a televised, ten part series produced by NJ Network. She has presented widely as keynote, moderator, or guest panelist at events such as Conference 2000 at the invitation of Singapore's Ministry of Education, in China at the invitation of the Ministry of Education and GKE, at NECC, TechSpo, and SchoolTech, for the US Dept. of Education, for the NJ Dept. of Education, for the NJ State School Board, and for groups including AT&T, NJASA, PBS, and IBM.

Kathryn Morgan
Bemidji State University, Minnesota

Jim Nazworthy
High Plains R*TEC

Jim Nazworthy is director of the South Central R*TEC soon to be the High Plains R*TEC. SCR*TEC works to bring about reform in education by fostering the use of distributed learning environments. Their strategy is to provide the opportunity for just-in-time learning objects that are created by experienced educators. The SCR*TEC strategy is built on the notion of every educator as both information provider and information consumer, which creates a demand-based learning object economy as opposed to a supply-based learning economy. Jim is now the Director of the Advanced Learning Technologies (ALTec) division of the Center for Research on Learning at the University of Kansas. ALTec operates the High Plains R*TEC, the 21st Century Chautauqua PT3 Catalyst Grant, and several other educational technology projects. Before coming to the R*TEC, Nazworthy taught secondary math and science. Nazworthy co-developed a computational science curriculum at the secondary level through projects sponsored by the Cornell Theory Center and the Pittsburgh Supercomputing Center. The project-based computational science model became the foundation of an NSF supported, virtual education community. The student project team was the base unit of this distributed education model. Teachers mentored local students on process objectives and students from other schools on content objectives for a project in their area of expertise. The virtual education consortium model provided for distributed curriculum via a shared assessment and project management structure. While pursuing a Doctorate in educational information technology at the University of Kansas, Nazworthy has research interests in distributed learning environments, learning objects, and knowledge Management.

Bill Penuel
SRI International

Dr. Bill Penuel is a research social scientist at the Center for Technology in Learning at SRI International. His research focuses on the assessment and evaluation of technology-based projects designed to support teachers, principals, and district administrators in implementing collaborative school reform initiatives. He is particularly interested in the study of how school professionals interpret and use assessment data in planning for these initiatives. Currently, he is working as an evaluator on the Joint Venture: Silicon Valley Challenge 2000 project, the GLOBE project, and the Joyce Foundation funded study of technical supports for urban high school reform. Prior to coming to SRI, Dr. Penuel worked a program evaluator on projects in San Francisco, Nashville, and Cobb County, Georgia public schools and as a business partner of the Learning Society Network at OISE/University of Toronto.

Barbara Reeves
State Technology Director, MD

Barbara Reeves is currently the Director of Instructional Technology at the Maryland State Department of Education. Her unit provides leadership and coordination for implementation of Maryland's long-range State Technology Plan. As part of that implementation, the Instructional Technology Unit administers the State and federal programs that provide funding for technology in local schools and school districts in Maryland. Previously at the Maryland State Department of Education, Ms. Reeves coordinated several projects related to technology, including the development of a multimedia tool to help classroom teachers learn about effective teaching practices. In 1988, she developed an instructional guide for teachers entitled "Computers in the Writing Program" that provided an overview on how computers, and, especially, word processing, can support all aspects of the writing process. Ms. Reeves was a high school teacher in Baltimore County for fifteen years before coming to the Maryland State Department of Education in 1987.

Sarah Skerker
Mantua Elementary School
Fairfax County Public Schools, Virginia

Sarah Skerker, technology specialist, is director of the award winning Mantua Distance Learning Center, at Mantua Elementary in Fairfax, Virginia. She has been instrumental in establishing distance learning as a value-added application in the K-6 environment. Mrs. Skerker has worked with general education, English as Second language, learning disabled, Deaf, and gifted and talented students. She also serves as director of Mantua's One-to One Immersion in Technology mobile computing initiative. Mrs. Skerker is an innovator in the use of educational technology and has been instrumental in the development and implementation of Mantua: A Basic School Powered by Technology. Sarah Skerker is an exceptional teacher, typifying the positive characteristics that set one apart for special recognition. She is the recipient of the 1999 Hearlihy/Foundation for Technology Education Scholarship, Excellence in Teaching/Integrating Technology, February 1999. She was awarded Honorable Mention on the USA Today All-USA Teacher Team, January 1998. Mrs. Skerker has also received many grants including the FCPS Education Foundation Sallie Mae Teaching with Technology Grant, January 1999, and Virginia Society for Technology in Education 1998-99 Minigrant. She has also given numerous presentations at national and international conferences.

David Thornburg
The Thornburg Center

As the founder and Director of Global Operations for the Thornburg Center, and as Senior Fellow of the Congressional Institute for the Future, David Thornburg conducts research and provides staff development in the areas of educational futures, multimedia, communications and whole mind education throughout the Americas. He helps clients to think intelligently about the future and is active in exploring ways that telecommunications and multimedia will change the face of learning, both at home and in the classroom. His educational philosophy is based on the idea that students learn best when they are constructors of their own knowledge. He also believes that students who are taught in ways that honor their learning styles and dominant intelligences retain the native engagement with learning with which they entered school. A central theme of his work is that we must prepare students for their future, not for our past. Dr. Thornburg is the recipient of several awards for product design and is the recipient of both the Golden and Platinum Disk awards from CUE (Computer Using Educators, Inc.) for his contributions to the advancement of learning and learning technologies. In 1999 he was selected as one of twenty "pioneers" in the field of educational technology by ISTE, the premiere organization devoted to the advancement of technology in learning, and was named by Technology and Learning magazine as one of the top ten most influential people in the field of educational technology in the past twenty years.

Kevin Warner
Cisco Systems

Kevin Warner is Director of Worldwide Education at Cisco Systems. He is responsible for developing strategy and implementation plans for the Cisco Networking Academy program - a program that teaches high school and college students the skills they need to design, build and maintain computer networks. Mr. Warner formerly held several marketing positions at Apple Computer, most recently as program manager, Education Marketing and Customer Programs. Mr. Warner holds a B.A. degree in economics with an emphasis in management and public policy from the University of California at Davis.

BREAKOUT SESSION RESEARCHERS & EVALUATORS

Laura Blasi
University of Virginia

Concerned with issues of equity and technology, Laura Blasi is a fellow at the Center for Technology and Teacher Education, while working on her dissertation at the Curry School of Education. She has been working on the evaluation of educational technology in k-12 and university settings for the past three years. She has also been part of the OERI's Gender Equity Panel, and has been creating content for a Web-based project for PBS titled: Racial Legacies and Learning. Prior to joining the Center, she developed programs for the Association of American Colleges and Universities including DiversityWeb, after earning her Masters at Georgetown University. She arrived in DC after teaching English in Japan for two years at a private school, and continues to study issues related to language and literacy in the context of technology.

Elsie L. Brumback
Former Director of Educational Technology
North Carolina Department of Public Instruction

Elsie L. Brumback retired in December, 1998, after having served the agency for the past 25 years in various technology leadership roles. Prior to joining the NC Department of Public Instruction, she was Supervisor of Media and Technology for many years in Fairfax County Public Schools, Fairfax, Virginia. In September 1998, Education Secretary Richard Riley named Mrs. Brumback to the U.S. Department of Education's 18-member Technology Expert Panel and at the first meeting of the Panel, she was selected by her peers to co-chair this national initiative. In February 1999, she was selected by the North Carolina Education Cabinet to chair the North Carolina School Technology User's Task Force II. Working with UNC-General Administration, Community Colleges, and the Department of Public Instruction, this Task Force assessed the progress made by the various education institutions in North Carolina since the initial Task Force Report was issued in 1995 and crafted a new set of recommendations for the 21st Century. The Report of Task Force II was presented to key educational leaders and policy makers on April 4, 2000, and will be used as a roadmap for preparing teachers to acquire the skills necessary to fully integrate technology into the teaching/learning process. During the past year, Mrs. Brumback has served as an educational technology consultant to various groups and agencies; including the National Governor's Association, the Council of Chief State School Officers, the US Department of Education, SERVE/SEIR*TEC, several State Departments of Education, etc.

Walter Heinecke
University of Virginia

Walter F. Heinecke is Assistant Professor of Educational Policy and Evaluation at the Curry School, University of Virginia. He received his doctorate in Educational Leadership and Policy Studies from Arizona State University in 1997. He teaches courses in research and evaluation methodology and educational technology policy. His research interests include the implementation and the evaluation/measurement of the impact of technology in preservice teacher education and in K-12 learning environments. His research primarily focuses on the impact of policies on teachers and students. He is currently evaluator of two U.S. Department of Education Preparing Tomorrow's Teachers for Technology Grants. He also co-edits the annual: Research Methods in Educational Technology, published by Information Age Press.

Margaret Honey
Director of EDC's Center for Children and Technology (CCT)

Margaret Honey has worked in the field of educational technology since 1981. Her primary research interests include the role of technology in school reform, the use of telecommunications technology to support online learning communities, and gender and technology, including issues of equity and access. Dr. Honey's studies include the first national survey to look at K-12 educators' use of telecommunications, one of the first development projects to cultivate the Internet as an environment in which to conduct teacher professional development (http://www.edc.org/CCT/mlf/MLF.html), and the nationally recognized Union City Online project, investigating the educational potential of networked, technologies when coupled with district-wide systemic reform (http://www.union-city.k12.nj.us). Currently, she is directing Project Hiller, a longitudinal study funded by the National Science Foundation on the impact of ubiquitous technologies in a school district that has overcome many of the initial challenges of urban school reform and technology integration. Dr. Honey regularly contributes to educational publications and presents at major technology and education conferences. She has served on the board of the Consortium for School Networking and serves on advisory boards of math, science and technology projects nationwide. She holds a doctorate in developmental psychology from Columbia University.

Barbara McCoombs
University of Denver

Barbara McCoombs has a Ph.D. in Educational Psychology from Florida State University. She is Senior Researcher at the Denver Research Institute located on the University of Denver's campus in Denver, Colorado. She has more than 25 years of experience directing research and development efforts in a wide range of basic and applied areas. Her particular expertise is in the area of motivational and self-development training programs for empowering youth and adults. She is the primary author of the "Learner-Centered Psychological Principles: A Framework for School Redesign and Reform" being disseminated by the American Psychological Association's Task Force on Psychology in Education. Under her direction, her group has recently completed a video-supported professional development program for staff developers and teachers based on the Principles, entitled FOR OUR STUDENTS, FOR OURSELVES: Putting Learner-Centered Principles into Practice (Part 1) and Stories of Change toward Learner-Centered School and Classroom Practices (Part 2). Her concept of a K-16 seamless professional development model is described in her book, published by Jossey-Bass in March 1997 and co-authored with Jo Sue Whisler, entitled "The Learner-Centered Classroom and School: Strategies for Enhancing Student Motivation and Achievement". This book also describes a set of K-16 self-assessment and reflection tools for teachers to use in determining the degree to which their beliefs and classroom practices are "learner-centered" from their own and their students' perspectives. A second book, which she co-edited with Nadine Lambert, entitled "How Students Learn: Reforming Schools through Learner-Centered Education", was published by the American Psychological Association in January 1998 and contains a collection of chapters that provide the research base for learner-centered practices at the school and classroom levels. In addition, she helped create a video-supported program. And Learning for All, to inspire a new vision of American education and bring information and useful strategies related to effective learner-centered practice to school administrators, teachers, parents, and school boards. Finally, she has developed a CD-ROM supported education program, entitled The Sun's Joules, for the Department of Energy and National Renewable Energy Laboratory on the topic of renewable energy for middle and high school students. This problem-based, learner-centered, standards-based, and interdisciplinary program includes a Teacher Guide with examples of learning activities and units for teachers to build upon in their own lessons, Facilitator Manual for supporting a two-day workshop on program implementation, and a Standards Reference Document of Colorado and national standards for mapping program content to local standards.

Robert McNergney

Robert McNergney is professor in the Curry School of Education at the University of Virginia. He teaches courses in educational foundations, evaluation, writing, and research. He also teaches a set of Internet-based, case-based courses for educators in the United States, Canada, England, and Scandinavia. McNergney has co-authored three books and edited four. His writing has appeared in the Handbook of Research on Teacher Education, Educational Researcher, Journal of Teacher Education, The Washington Post, and The New York Times. He served as chair of the Technology Committee for the American Association of Colleges for Teacher Education, 1999-2000.

Cathie Norris
University of North Texas

Bernajean Porter
Co-Director of PDK Technology Audit Services

Bernajean Porter is currently CEO of Education Technology Planners, Inc, a consulting group supporting future searches, community-based planning, conducting technology and learning assessment audits, designing and implementing staff development programs, and preparing district leadership for leading out change. With over thirty years of experience as an educator, Bernajean's seminars and work reflect extensive, practical experience in technology planning projects, TLCF grants, and technology audits with over 700 districts throughout the United States and overseas. She recently developed the Technology Planning Blueprint and NextSteps assessment toolkit for the State of Illinois leadership team. She is author of Grappling with Accountability: Resource Tools for Organizing and Assessing Technology for Student Results. Her work uses the application of systems thinking and chaos theory to deal with the challenges of change and re-culturing efforts in education today.

Saul Rockman
Rockman, et al

Saul Rockman consults on education and technology for corporations, state and federal agencies, and educational organizations. He established Rockman et al in 1990 after leaving the education marketing group of Apple Computer where he was manager of education research. While at Apple, Rockman disseminated research findings on the impact of computers for learning and managed a large-scale effects study. He helped Apple establish partnerships with educational organizations for national technology policy development. Prior to joining Apple, Rockman was director of technology programs at the Far West Regional Educational Laboratory (now WestEd) in San Francisco, California. There he conducted research on teacher training programs in technology, analyzed technology resources in social studies, developed distance education projects for rural schools, served as executive producer of award-winning videos on child care, and conducted technology policy research. Before moving to San Francisco, Rockman was director of research at the Agency for Instructional Technology in Bloomington, Indiana. At AIT, he conducted research on numerous instructional television programs for a consortium of state and provincial educational agencies and developed and managed a computer and video project on problem solving. He was noted for creating innovative evaluation techniques for television and computer materials. Rockman writes and speaks on the impact of technology on learning, equity issues and technology policy, children s television, and evaluation methodology. He is the producer of award-winning children s television, and designer of award-winning multimedia projects, and has consulted for diverse organizations ranging from the Department of Education to The Disney Channel. He has written successful Challenge Grant proposals and is holds the evaluation contract for four Challenge Grant projects. Current and recent clients of Rockman et al include: Ameritech, Apple Computer, Autodesk, Br derbund, The Buddy Project, California Department of Education, Claris, Compaq Computer, Congressional Office of Technology Assessment, Children s Television Workshop, Indiana Department of Education, Microsoft, Pacific Bell, PBS, TRO, US West, WarnerActive, and several NSF and Department of Education projects.

Michael Russell
Boston College

Michael Russell is a Senior Research Associate for the Center for the Study of Testing, Evaluation and Educational Policy at Boston College and as an Assistant Research Professor for the Lynch School of Education at Boston College. He has worked on a number of projects related to school reform and educational technology. These projects include examining the impact educational technologies have on teaching and learning in the classroom, studying changes teachers make to their instructional practices in order to help students achieve state-level standards, assessing the effect of comprehensive school reform on students' attitudes and performance, and monitoring the ways in which state-level testing programs impact school and classroom practices. In addition, he has conducted several studies that examine the accuracy with which paper-and-pencil writing tests measure the performance of students accustomed to working on computers. Looking to the future, he hopes to continue examining the implications educational technology have for testing student performance and studying the impact educational technologies have on teaching and learning. He received his B.A. from Brown University, a Masters in Secondary Education from Boston College, and a Ph.D. in Educational Research, Measurement and Evaluation from Boston College.

Lynne Schrum
University of Georgia

Lynne Schrum received her M. A. in Elementary Education and Learning Disabilities from the University of Evansville, and in 1991, a Ph.D. in Curriculum and Instruction from the University of Oregon. She has taught courses on distance learning, telecommunications, research methods, and technology in schools. Dr. Schrum's research and teaching focus on online and distance learning, implementation of technological innovations in education, and appropriate uses of information technology in K-12 education. She is the immediate past-president of the International Society for Technology in Education (ISTE). Dr. Schrum has written two books and numerous articles and monographs on these subjects, and consults and speaks with post-secondary educators, K-12 educators and administrators, and policy makers throughout the US and in many countries around the world.

Charol Shakeshaft
Hofstra University

Elliot Soloway
Professor
University of Michigan

Elliot Soloway is on the faculty at the University of Michigan; he is a Professor in College of Engineering, School of Education, and School of Information. For the past 10 years, Soloway and his colleagues in the Center for Highly Interactive Computing in Education (Hi-CE) - now composed of over 60 undergraduate and graduate students - have been exploring the ways in which computing and communications technologies can be the catalyst in bringing a constructivist, project-based pedagogy to science classrooms. The Hi-CE group is developing science curricula that embeds technology into the everyday experiences of students and teachers. As well, the Hi-CE group is developing professional development workshops and materials that support teachers in carrying out these project-based, technology-pervasive curricula in their classrooms. Attempting to integrate theory and practice in public schools, Hi-CE now works in over 20 schools in cities such as Detroit MI and towns such as Pleasantville NJ. There is an opportunity now for making major changes in education, with technology as the Trojan Mouse. He and his colleagues are working full-tilt to take advantage of this once-in-a-lifetime opportunity.

Cheryl Williams
National School Boards Association

BREAKOUT SESSION FACILITATORS & RECORDERS

Gina Ameta-Shin
Education Consultant

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ED HOME EDTECH CONFERENCE 2000 *This page last modified January 26, 2001 (bay).*

The Secretary's Conference on Educational Technology 2000

SPOTLIGHT SCHOOLS (BY STATE)

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

A

Shelby County Schools
Columbiana, Alabama

Shelby County was created by an act of the Mississippi Territorial General Assembly on February 7, 1817. It is named for Isaac Shelby, a Revolutionary War soldier and a governor of Kentucky. The county seat is Columbiana, which is 35 miles south of Birmingham and 75 miles north of Montgomery. The citizens of Shelby County represent a wide variety of socioeconomic and racial diversity. The 1997 population, as determined by the US Census Population, was 134,872. Shelby County is ranked 6th in population among Alabama counties. 44% of the residents work in Shelby County. The unemployment rate in Shelby County is less than 2 percent. Currently there are 33 schools in the system.

Located in the heart of Alabama, Shelby County is the fastest growing county in the state. During the past seven years the county has experienced a yearly growth rate of 34.68%. The Shelby County School System is the seventh largest in Alabama. The Board of Education employs 1571 professional staff members. Including support personnel and bus drivers, a total of 2554 employees maintain the Shelby County School System. The enrollment for the 2000-01 school year will exceed just over 20,000 students. There are 8 high schools, 8 middle schools, 14 elementary schools, a School of Technology and the Linda Nolen Learning Center and an Instructional Services Center. Two new elementary schools are scheduled to be completed in the fall of 2000 and one in the fall of 2001. The Southern Association of Colleges and Schools has accredited all schools.

The main focus of our school system is on student learning and effective teaching strategies. The challenge to prepare students to be productive workers and citizens in the 21st Century is the driving force behind our staff development programs and continuous training of Shelby County Board of Education employees. We challenge our students to become the best they can be by providing a curriculum, which addresses the needs of a changing world in an environment conducive to learning.

Shelby County Schools Mission Statement:
To provide a system of education which is committed to academic excellence and which provides education of the highest quality to all Shelby County school students, preparing them for the twenty-first century.

Shelby County Board of Education is committed to providing access to technology as a means of achieving this mission. In the past three years, a wide area network has been installed which connects all 33 school sites and administrative offices. With beginning of the 2000-01 school year, all classroom will have at least one computer which provides access to the Internet, e-mail and a wide variety of instructional and productivity software.

Realizing that technology without training is ineffective, Shelby County Schools through the Technology Office provide weekly training during and after school. A training program called ProTech was implemented in the summer of 1999. In this training program teams of teachers are trained intensively for three days during the summer with follow-up training and support during the school year. A total of 156 teachers have received this training in the past two summers. These teachers receive a computer for their classroom and a stipend in exchange for modeling the curriculum integration of technology in the local schools. The ProTech teams also provide a minimum of six hours of technology training for staff members at their schools. The use of technology in instruction has increased tremendously as a result of this training approach. Several school systems in the state have modeled this program. Many of the training projects and handouts as well as other implementation ideas are posted on the Shelby County Schools website at www.shelbyed.k12.al.us.

East Project
Little Rock, Arkansas

Orangewood Elementary School
Washington School District
Phoenix, Arizona

Orangewood School is located in north central Phoenix. Previously farmland and citrus orchards, the neighborhood has retained a sense of rural Phoenix since the time of the school's inception, in 1955, even as the city has grown around and well beyond it. In 1998, Orangewood was reborn and rebuilt on the same property as a modern two-story facility with upgraded electrical, cooling and environmental standards.

Currently, Orangewood serves a diverse K-6 population of 775 students (50% free/reduced lunch, 10% English Language Learners, 11% Gifted and 7% Special Education students). In keeping with our school mission to prepare students to become literate, creative, responsible, lifelong learners in partnership with families and the community, our fine arts program is a priority and is strongly supported and integrated throughout the curriculum. Community involvement and school-home communication are high priorities as well. Additionally, Orangewood serves as a field-based teacher training site for Arizona State University West students.

With the support and guidance of principal Dr. Peggy George, Orangewood has vaulted into the information age during the last three years. Funded by a 1996 district technology bond of $30 million, we have computerized the library and created a Macintosh lab with Internet connections. All classrooms have a minimum of one teacher/student station consisting of an internet-linked computer, printer, VCR, laserdisc player and 27-inch monitor. Three classroom sets of Alphasmart keyboards allow keyboarding practice and entire classes completing writing assignments as a group. Phones with voice mail are found in each classroom, and the Phonemaster allows us to do outdials to parents, and conversely allows parents to access prerecorded messages from teachers.

We anticipate cable connections to each classroom in the coming months. Plans call for classroom stations to be used for attendance and grading, linking to the SASIxp data management program, which is capable of providing data analysis for school planning and accountability throughout the district. We will also explore the full capabilities of our closed circuit television system.

An aggressive technology training component has supported the new hardware. The district support includes a Technology Training staff of 6 full-time trainers, one training coordinator and at least two technology mentors in each school. The MIS (Management Information System) department has a staff of twenty-five people providing technical assistance and maintenance of all technology including a Help Desk hotline. Opportunities for Technology training have been offered to staff through numerous Eisenhower grant projects as an additional piece of our ASU West partnership. These projects have moved our teachers to the forefront of technology expertise in our district.

Strong evidence exists schoolwide as to the power of technology to motivate student learning. A wide variety of creative computer lab projects adorn the walls, methods of student research have changed forever and enthusiasm abounds. As we strive at our site to find effective technology tools and methods for best learning, our district technology committee has been developing technology curriculum and is beginning to integrate it into the existing curricula, so that technology will become more logically connected to everyday classroom activities.

Project Venture
Arizona

Since the very early days of organized education in America, teachers have been lighting the torch of learning by using the best available tools for teaching. None have been more challenging to integrate than the technology of computers and online learning. While many districts have pursued the integration of technology into the classroom since the early eighties, the vision for the use of technology in education has changed dramatically over the last decade. In the early days, technology was used mostly to reinforce skills already taught through "drill and practice" software. Today, we recognize that the use of technology in isolation from meaningful classroom curriculum will not impact student achievement. However, computers can have a significant impact on student achievement given appropriate staff development. Project Venture will address the need for comprehensive staff development and curriculum integration by assisting our teachers to become pioneers in the use of technology and then to become guides for others seeking to undertake this venture into the new frontier of teaching and learning.

Project Venture will recruit and train a cadre of master trainers (guides) who will provide classes for large groups of staff members as well as modeling effective practices in classrooms throughout the consortium. Classroom teachers will be trained to use technology in a collaborative learning environment that focuses on student mastery of Arizona State Content Standards. Our teachers' classrooms will have Internet connectivity and be equipped with a five-station multi-media lab, printer and presentation device. Our project objectives are:

Objective 1.0 To increase the number of teachers trained to use technology for teaching and learning

Objective 2.0 To develop and implement curriculum materials that are in alignment to State Content Standards and includes the integration of technology.

Objective 3.0 To develop and implement an ongoing evaluation protocol that assists with project refinement, implementation and ensures sustainability and replication by the end of the project.

The consortium for Project Venture is comprised of Creighton Elementary School District; the Arizona Department of Education (ADE); a tri-district consortium consisting of Tempe Union High School District and its two feeder districts, Tempe and Kyrene Elementary; and Maricopa County Small Schools Consortium (MCSSC) and its eleven rural school districts. The project will impact 3,031 teachers and their 54,062 students of whom 43% are low-income and 42% are minority. Business partnerships include CISCO, Compaq, and Microsoft who will provide the necessary hardware and networking software infrastructure for the project. Arizona State University (ASU) and Stevens Institute for Technology are also consortium partners. ASU will provide formative as well an objective summative evaluation. Stevens Institute will provide access to their Internet Training Curriculum. Creighton District will act as fiscal agent and provide project direction and oversight. The staff development program to be refined during Project Venture has been successfully piloted by Creighton District. The ADE will coordinate inservice training through its Regional Training Centers and disseminate curriculum and training materials through the State Infrastructure. The Tri-District Consortium will develop curriculum that is aligned with State Content Standards and make it available for project use. MCSSC will provide a small school setting for training where the needs are in contrast to those in large urban districts.

A critical mass of teachers will develop the skills and knowledge to integrate technology and extend that knowledge to other teachers. The project will result in the refinement and implementation of a successful staff development program that trains teachers to use technology for teaching and learning. Project Venture will be sustainable and replicable by other institutions.

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TOP

Project S.I.T.E.
Enterprise's 4-year Technology Project
Enterprise School District
Redding, California

Project S.I.T.E. (School Integration of Technology in Education), is a federally funded project that is orchestrated by Tom Armelino, Assistant Superintendent of Instruction, Enterprise Elementary School District. Project S.I.T.E. seeks to enhance learning for all students in the classroom by using technology as a tool that is integrated into the curriculum exclusively by classroom teachers within each school. Project S.I.T.E. offers an alternative strategy to classroom technology integration that differs greatly from approaches used in most American schools by:

- Employing a strategy of staged growth over three years, as one-third of a school's classroom teaching faculty enters the project each year.
- Enabling classroom teachers to provide leadership for other classroom teachers. Each year a lead teacher in every school will work closely with one-third of the staff to support technology integration into their classrooms.
- Through our Even Start program we will "put the most powerful technologies in the least powerful hands" through our family outreach program for 2-4 year old children.

The fundamental goal of Project S.I.T.E. is not that students learn how to use technology. Rather that students learn, using technology. Specifically, Project S.I.T.E. seeks the following outcomes:

1. Allow classroom teachers to use technology to accommodate a greater range of learning styles.
2. Help students master core curriculum skills.
3. Structure classroom experiences to involve cooperative learning, cross-age tutoring, and higher order thinking.

Students who use technology tools to gain both a deeper understanding of the subjects they study, and learn how to access information with the tips of their fingers.
Our outcomes will be accomplished by:

- Staged Participation: By providing different entry points that allow regular classroom teachers in each building to join the project over three consecutive years, Project S.I.T.E. provides a gradual (but inevitable) inclusion process for teachers with different levels of technology skills and interest.
- Peer Leadership: Three regular classroom teachers in each school receive training to become, on an annual rotating basis, the Lead Teacher within their building.
- Enabling Support: Every participating teacher receives mentoring, support for classroom technology integration and a menu of professional development options. A Tech. IA (Technology Instructional Assistant) supports each Lead Teacher.
- Hardware & Software: New multimedia hardware and curriculum based software is evident in our classrooms. Each Lead Teacher receives a bank of computers for student use and a multimedia display in the classroom. District software is available through software metering on our district server.

The project makes it possible for regular classroom teachers to:

- Routinely integrate multimedia instructional materials in core subjects such as reading, mathematics, science, and writing;
- Exploit the value of technology tools in accommodating the neglected learning styles and needs of students who learn "differently";
- Harness technology tools to promote higher order instructional goals recommended by the state board of education and
- Evaluate the progress of students through ongoing collection of data and state mandated Stanford 9 test.

San Diego Unified School District
San Diego, California

The San Diego Unified School District is the eighth largest school district in the country. More than 27% of its students are classified "English language learners" (ELL) who speak more than 52 native languages. Over half the ELL students are economically disadvantaged. There is a need to improve academic achievement among many students throughout the school system. As the program is expanded to include all San Diego School System students by the year 2000, more than 140,000 children will participate.

This program includes strong staff development and evaluation components that are woven into ongoing curriculum development and implementation. A major focus is the development and disemination of content-based and standards-driven projects which integrate the use of technology as a tool for learning. The program stresses systemic reform, works with other district initiatives such as the San Diego Urban Systemic Initiative (SD-USI), and contains elements that are in compliance with recommendations of state and national calls to reform, including the Goals 2000 Act.

The Patterns Project will achieve these goals through the complementary use of six technology-based strategies:

1. Web as Input: Using the World Wide Web as a resource for information and learning.
2. Web as Output: Using the Web as a publication vehicle for student and teacher work.
3. Graphical Organizing Tools: Using software, such as Inspiration, Stencil-It, TimeLiner, and Cocoa, to help students organize and manipulate information and ideas.
4. Patterns of Thinking: Teaching habits of mind, including inductive and deductive reasoning, through the use of technology tools and within the context of curriculum standards.
5. Communal Knowledge Construction: Gathering and cataloging the intellectual products of teachers, students, parents, community organizations, and businesses and making them available and open to feedback from others by means of a centralized data base.
6. Service Learning: Applying information literacy skills to provide needed services for parents, other students, and local community members.

Douglas County School District
Castle Rock, Colorado

Winchester School District
Winsted, Connecticut

Goals:
1. To ensure that the use of technology is truly impacting student learning.
2. To fully integrate the use of technology into academic disciplines.
3. To improve student achievement in state mastery test through the use of technology.

Background:
Only four years ago the Winchester Public Schools owned just a few computers, most of which went unused, while those that were in operation were primarily limited to drill and practice. Since then the district has invested heavily in new technology, and has received numerous, state, TLCF and erate funds. It now has a state-of-the-art infrastructure with a minimum of two online computers per classroom, multiple labs, Local Area Networks (LANs) and Internet connectivity throughout the district. The school also developed partnerships with neighboring rural schools in Connecticut and Massachusetts to provide high quality, focused, multi-day professional development programs throughout the year. As an example, this summer over 400 days of instruction will be delivered. Nevertheless, last year the students did not meet the state's goals for reading comprehension and math competency as measured by the Connecticut Mastery Test (CMT).

Action Plan
The district performed an in-depth self-analysis of all aspects of the availability and use of technology, and compared itself to documented effective practices. While the general goals of the technology curriculum were preserved, the lesson plans were discarded and only those activities that clearly addressed academic curricular objectives were maintained. A Technology Integration Team was established that includes the media specialist, the director of technology, the assistant superintendent, and administrators and teachers with expertise in multiple aspects of technology and education. The team began its work with a comprehensive analysis of the curriculum, identifying areas for improvement, and gaining insight into how technology plays a significant role in supporting student learning. Each team member worked to establish well thought out math tasks and developed a process for tracking student growth based on CMT results. Two examples included: 1) The district tracked each student's reading growth by posting their pre and post Degree of Reading Power (DRP) tests results on the network. This helped the teachers look at each student's longitudinal growth and promoted the sharing of student assessment data. 2) Specific math lessons were designed to help improve the objectives that related to concepts that involve the use of fractions. These technology rich math activities were posted on the school's network in a math curriculum folder. After a student solved a problem, the teacher could then utilize an assessment rubric to evaluate the student's work. The rubric also can be used by the student to self-assess their own work, enabling them to focus on specific areas of improvement.

During the year, the following information has been posted on the district's network:
* Grade specific Math Tasks aligned with the CMT objectives.
* Math Task Assessment rubrics
* District developed CMT aligned Mathematics Benchmarks for each grade level, kindergarten through grade eight
* Mathematics curriculum framework from the Connecticut State Department of Education
* A summary of NCTM standards
* 1999 CMT scores for all students from grades 2-8.
* Guided Reading material
* Pre and Post DRP results for all students grades 2-8
* Four Blocks Reading Program information

The Technology Integration Team then continued their work by demonstrating, mentoring, following up and evaluating the use of these materials. Although the students have yet had the opportunity to take the 3rd Generation of the Connecticut Mastery Test, there has been a marked improvement in the targeted areas as measured by performance on school level testing, measured by rubrics, observations, attendance and student demonstrations and explanations of problems.

D

Henry M. Brader Elementary School
Newark Delaware

I

Bloom Trail High School
Chicago Heights, Illinois

Bloom Trail High School is the newer of two schools in Bloom District 206. Located approximately 40 miles south of Chicago, it opened as a four-year high school in the fall of 1976. The prior twelve years it housed the district's freshmen and sophomores.

Trail's diverse student body resides in Steger, Crete, Sauk Village, Ford Heights and Lynwood, with a significant portion from families below the poverty level.

Trail offers an equally diverse academic program for its 1,250-1,300 students, with technology playing a significant role in student learning and achievement.

That technology includes a robust T-1 connection to the Internet, and a LAN provides Internet connection to every classroom. Completing a four-year process, by December of this year there will be a networked Internet high performance computer in every academic classroom in the building, accessible to teachers.

There are seven large high performance computer labs at Bloom Trail, all connected to the Internet. Some are subject-specific, some are for Title I reading, and some are open labs available as needed by teachers. In addition, there are 19 internet-connected computers in the media center.

The two Title I math labs, graphic arts, yearbook and art classes have computer work group clusters (fewer than 10 computers).

To facilitate engaged learning and changes in the instructional process, technology also includes LCD projectors, digital cameras, scanners, laptops, and a 36-inch multi-purpose monitor with a full function Internet computer and VCR.

Overseeing the purchase, installation and maintenance of hardware, and serving as a troubleshooter for teachers, is the technology coordinator assigned to Bloom Trail High School.

Instructional resources targeting engaged learning are being used in math, science, social studies, reading and writing classes.

Extensive staff development included the use of specific equipment and programs, use of the Internet in classrooms, new dimensions for learning with technology, innovative instructional practices, engaged learning with technology, interdisciplinary learning, multimedia presentations, and new alternative assessment strategies and techniques.

Federal and state grants provided a majority of the funds for technology implementation, including infrastructure, hardware, software and staff development.

The community is able to access information about state-of-the-art technology and teaching at Bloom Trail through the Bloom District 206 web page.

Rich East High School
Olympia Fields, Ilinois

Rich East High School, located approximately 30 miles south of downtown Chicago, is a 9 - 12 high school located in Park Forest, IL. East currently serves 1200 students and is the original campus within Rich Township High Schools District 227. Park Forest gained status as an All-America City in 1953, as a tribute to the new school, the known as Rich High. The village, incorporated in 1948, had already won recognition as an exemplary prototype of the post-war, middle class, planned communities that came to define suburbia.

Located in southernmost Cook County, District 227 now consists of three separate high schools, Rich East, Rich Central and Rich South. Together they server 3300 students from all or part of seven communities: Chicago Heights, Country Club Hills, Matteson, Olympia Fields, Park Forest, Richton Park, and Tinley Park. The area is primarily residential and is culturally and socio-economically diverse. District-wide, the mobility rate is about 10 percent. The number of free and reduced lunches has more than tripled in the last nine years.

Community support is a key element in the ongoing success of District 227 schools. The district's high academic, social and behavioral expectations show results: the graduation rate is 90 per cent with over 80 percent college-bound. Students, teachers, and business partners work together to define goals and provide enriching opportunities for life-long learning. Partnership programs include job shadowing, skills assessment, and curriculum development that provides educational solutions to the challenges of the workplace.

District 227 maintains a leadership role in technology literacy. Rich East currently has six computer labs: accounting, CAD, keyboarding, writing, math/science, and media center. A long-range plan will provide technology to every classroom, office and lab, including wiring for voice, video and data connections. The plan includes staff development as well as student learning.
A Technology Literacy Challenge Fund grant supported a recently completed partnership research project with two neighboring high school districts. Students investigated and then reported on their topic - the historical impact of change as it relates to the future in the south suburban area - via the use of technology.

Students created PowerPoint presentations and developed brochures, posters, and web pages using such vehicles as Word, PhotoShop, DreamWeaver, and HTML. The information was shared with the school board, with community groups and through community access cablevision. Students worked in diverse, heterogeneous, collaborative groups determined by instructional tasks. The multidisciplinary project included English, reading, mathematics, and more.

Teachers, through the integration of technology into a standards-based curriculum, are helping students to achieve the Illinois State Learning Standards. Teachers facilitate group collaboration as co-learners and co-investigators of research and data collection. In order to do this, teachers must be willing to take risks and to explore areas outside of their expertise. Training and workshops for teachers have included Microsoft Word, Excel, Access, PowerPoint, DreamWeaver, Adobe PhotoShop, Internet, and HTML web design.

Students are exploring new areas as well, using new tools for research, engaging in new experiences, and developing new and useful products. As cognitive apprentices, they are engaged in authentic, challenging tasks, observing, and then applying and refining the thinking process. Students teach and learn from each other as they integrate knowledge and skills for themselves and for the community.

K

Holton School District Profile
Holton, Kansas

USD 336 is located in Holton, Kansas, 26 miles north of Topeka, the state capital. A new four lane highway, reservoir and numerous new businesses have led to a growing population. Holton, which has a population of 3,300, serves as the county seat of Jackson County.

Four schools are contained within USD 336: Colorado Elementary for grades K-2; Central Elementary for grades 3-5; Holton Middle School with grades 6-8; and Holton High School, a 4A-size school, with grades 9-12. The total student population for the district is 1086. The district has 97 teachers for an overall student to teacher ratio of 11:1.

USD 336 is the sponsoring district of a five-district special education cooperative which employs two administrators and 46 certified personnel.

Highly regarded for its strong educational offerings and professional staff, USD 336 has created a strong in-service program for staff development. The district is a leader in technology offerings for students at all levels.

In 1995, Holton USD 336 became the first school district in Jackson County to acquire a direct internet connection for its high school and by 1996 the district became the first internet service provider for Jackson County. Later, partnerships with surrounding districts were established enabling them to access internet services at a high rate of speed. Today a number of communities surrounding Holton have internet access via a local phone call through the schools. Currently more than 1,270 community patrons receive internet connectivity through Holton USD 336. In 1998, USD 336 used DSL technologies to create a wide area network. The district has also donated a computer along with free internet access to Beck-Bookman Public Library, a senior citizens center, two Jackson County nursing homes and the Fresh Start Adult Education program.

Over the past seven years the district has obtained numerous grants, totaling $346,189, from various state and federal agencies. Grant money has been used to purchase hardware and software, to establish new classes and to provide staff development.

Ashland Independent School District
Ashland, Kentucky

The Ashland Independent School District in Ashland, Kentucky considers itself to be a leader in the use of technology to support teaching and learning in the classroom. Technology permeates our district with over 1,000 networked computers and Internet/Email access for every classroom. With approximately 3,400 students in our district, we are seeking to make our technology an integral part of the curriculum with instructional software for grades K-12. This creates an environment where teachers and students become more proficient in using a wide variety of tools to enhance learning, problem solving, communication, collaboration, productivity and creativity. In addition, we hope to strengthen the home-school connection by expanding our district and school web sites with detailed information about school activities and by making our technology available to families and the community.

District Technology Vision Statement: "The Ashland Independent School District will provide 21st century technology that will empower the learning community to become information-literate critical thinkers to achieve lifelong learning goals in their personal, educational, and workplace environment."

5 District Technology Goals:

1. Develop a comprehensive three-year district technology plan for the effective implementation of technology that will provide appropriate guidelines for acquisition, training, and support for staff, students, and the community.
2. Construct a state-of-the-art network infrastructure to provide global communications and information literacy for schools and administration with sufficient technical support to extend, further develop, and keep the network operational.
3. Establish a robust staff development program to facilitate and evaluate the relevant use of technology with the highest standards of professionalism and training in order to empower staff members to embrace technology as a tool that can be utilized effectively across the curriculum.
4. Create, implement, and assess a spiral curriculum for students, which integrates technology in an engaged learning environment while meeting local, state, and national standards of excellence in a legal and ethical manner for the promotion of citizenship and technological leadership.
5. Identify needs for software and hardware acquisition through systematic planning at the district and building level to build an equitable, cost-effective technology base for our students and provide for refresh.

Kenton County Schools
Erlanger, Kentucky

Kenton County Schools, located in Erlanger, Kentucky is the 5th largest district in the state with 12,000 students. The district is dedicated to student learning and setting clear expectations about the learning that takes place each day. Effective resources, whether paper or electronic, are provided in support of this district goal.

With the Kentucky legislative action of 1992 awarding school districts Ed-Tech funds to be matched dollar for dollar by the local school district, Kenton County Schools have been able to run cabling to the classrooms, purchased computers and printers, provided full time technicians, build a support system of teams of teachers and students within each building to address building needs, provided digital cameras, scanners and projection devices, and offer software trainings for staff members. While each year we continue to expand the hardware, software, and professional development to staff and students, this year we are putting our resources into people that will assist teachers with the integration of technology into the curriculum.

During the past year, the Kentucky Department of Education Professional Standards Committee created technology standards that all teachers are expected to achieve, whether that teacher is a new or experienced teacher. The district, in support of these standards, used the Technology Literacy Challenge Fund grant dollars for professional development to support our teachers and create an environment where all teachers are learners.

This school year a Technology Resource Teacher has been added to the technology staff. This person is available to teachers to help with the integration of technology into their curriculum. This may be accomplished in several ways: model teaching, help with lesson plans, support services, consulting in various ways, or finding resources to accompany lessons.

To further support the teachers a call for integrator/trainers was advertised among staff members. The plan was to hire 12 experienced and effective teachers in the integration of technology in the curriculum. Those selected would work with teachers in their buildings as well as within the district to empower and support teachers. Their mission was to:
- Provide individual consulting time with teachers
- Focus on content that the staff is currently teaching
- Ask the teacher to identify an area in which they want to begin
- Start small and meaningful to the teachers
- Create a plan of action which includes how to acquires materials and support
- Assist in planning lessons
- Model technology in their classroom
- Do collaborative teaching when necessary
- Provide resources
- Partner the teacher with someone else who is using that same technology
- Follow-up within 2-3 weeks to see how the teacher is doing.

We are looking for measurable progress in the area of technology with our students. To help teachers meet this goal the state has provided an electronic self survey (Profiler - SCR*Tec) that supports the professional technology standards. The results of this survey helps teachers, building administrators and the technology staff plan appropriate professional development.

With this support it is hoped that teachers will become learners and then teachers to our learning community of students.

L

Many High School
Many, Louisiana

M

Rockledge Elementary School
Bowie, Maryland

Rockledge Elementary, a K-6 comprehensive school of 625 students, is located in Prince George's County, Bowie, Maryland. Seven years ago our technology consisted of outdated computers and basic audiovisual equipment. Our road to improvement began with a new administrator who spearheaded a technology committee made up of staff members and interested parents. Our ongoing technology plan initially addressed the procurement of space, selection of hardware, and creation of a curriculum technology infusion program. Funds received from increased scores in the Maryland Schools Performance Assessment Program provided seed money to purchase new PCs for our computer laboratory. At least one computer is in every classroom, converters allow instructors to use them with their television monitors for whole classroom instruction; staff members are encouraged to take advantage of county and peer technology training. Thanks to the committee's initiative, all classrooms and administrative offices are online.

Our philosophy is to provide all students with the opportunity to become information literate and to provide staff training so that all instructors may infuse technology into their curricular areas. Scheduling of classes for the Computer Lab and the Media Center has evolved over the past three years; the best of fixed and flexible schedule options combine to yield enormous benefits for students and teachers. The Computer Technician works closely with the Media Specialist to provide the most recent and up-to-date technological applications. Together they plan with the classroom teachers how best to use their media and computer time, facilities, equipment, and software. Often the allocated time is combined and team-taught; especially in extended research assignments. The Computer Technician, Media Specialist, and classroom teachers work cooperatively on software selection and evaluation, each bringing important areas of expertise to the process.

The Technology Literacy Challenge Fund Grant is a federally funded initiative in which Rockledge participated during the 1999-2000 school year. The Media Specialist, with a third and fifth grade teacher forms a cooperative triad whose goal was to infuse technology into existing curriculum. Monthly meetings with others in the program provide for staff training sessions and peer review of lesson plans and projects, triad members present at local conferences, technology infused lesson plans are developed for online publication, and the triad develops and implements staff training opportunities. Our school has been selected to participate in this program for a second year, 2000-2001, allowing our group to include two more classroom teachers, from second and fourth grades respectively.

Video teleconferencing has been made available to the students by one of our parent's employers; emails to our overseas partners are part of the daily routine, and parents may find homework assignments online. Ten classrooms and the Media Center now house computers with portable keyboards allowing for more student interaction and flexibility. This year a set of portable microprocessors will be used in the classrooms. Students are encouraged to explore all forms of technology. Production is an assessment as well as a culminating activity. It is not unexpected for students to publish their research as a PowerPoint while incorporating digital pictures; or they might make it a news report for the morning television show, directed and produced by the sixth grade. Students have video portfolios recording their progress and accomplishments; parent volunteers do the actual filming. The resources on the Internet are made available to the students through the Computer Lab, Media Center, and their classroom computers. We strive to continue with our technology and information literacy goals knowing the importance for our children's success in the twenty-first century. Our team approach ensures that every child will have the best resources our school has to offer.

Eugene Burroughs Middle School
Prince George's County, Maryland

Eugene Burroughs Middle School, located in southern Prince George's County, Maryland, is a combined middle school consisting of 750 students. The school offers a Magnet Continuity program, "The Center for the Enhancement of Higher Order Thinking Skills through Technology". Eugene Burroughs also serves to provide a Talented and Gifted Magnet Program to those TAG identified students who comprise about half of our sixth grade class. There are 120 sixth graders who feed into the school from our neighboring elementary. Grades 7 and 8 have approximately 310 students in each, half who reside within our attendance area and half who receive magnet continuity from a Traditional/Classical feeder elementary. The school's racial composition is 75% African American, 20% Caucasian, and the remainder 5% is divided between Filipino, Asian, and American Indian. Twenty one percent receive free or reduced lunch. Eugene Burroughs Middle School is among the highest performing middle schools in Prince George's County. The 1998 index was 71.1.

As "The Center for the Enhancement of Higher Order Thinking Skills through Technology", the school offers a special program which highlights the inclusion model for the teaching of higher order thinking skills and the infusion of technology with over 300 network computers. Eugene Burroughs Middle School was a national pilot for a project which created a partnership between Jostens, makers and distributors of instructional software and Workforce 2000, a company providing software and training designed to help teachers plan instruction that is correlated to MSDE outcomes and indicators. This "High Performance Instruction Model" utilizes technology through Task Builder in the alignment of instruction with instructional outcomes and the development of performance assessments.

Instructionally, both students and teachers at Eugene Burroughs Middle School benefit from our four computer labs. Students have the opportunity to frequent each of the computer labs weekly, that is once in each of the four core content subjects of Reading/ Language Arts, Mathematics, Social Studies and Science. Teachers utilize Task Builder and Power Point in the design and delivery of unit lesson plans. The use of JCAT pre tests provide early indicators of students' strengths and weaknesses. Progress is monitored and appropriate instructional adjustments are made. All have direct Internet access.

Organizationally, teachers at Eugene Burroughs Middle School benefit from our internal and external e-mail and Microsoft Office. With a computer on each teacher's desktop, educators have access to our student information system. A student photo along with information regarding home address, parent/guardian phone numbers, student schedule, attendance, behavior are accessible to staff members.

Technology at Eugene Burroughs Middle School is the one tool that empowers the acquisition of knowledge and enhances the learning process.

Maine State Department of Education
Augusta, Maine

Springfield Massachusetts Public Schools
Springfield, Massachusetts

Demographics: With 156,983 residents, the city of Springfield is the largest city in Western Massachusetts and enjoys a 359 year history as "The City of Homes," the birthplace of Theodor "Dr. Seuss" Geisel (March 2, 1904), and the birthplace of basketball (Dr. James Naismith, 1891). Springfield is strategically located 90 miles west of Boston and 150 miles north of New York City.

In the Springfield Public Schools, the second largest school district in New England, 25,918 students attend classes in forty-eight schools located throughout the city. The school district population is 42% Hispanic, 26% Caucasian, 30% African-American, and 2% Asian. Approximately 78% of the students were classified as low-income according to their eligibility for free or reduced price lunches. In the 1999-2000 school year, Springfield began a "Universal Free Lunch Program" for all its students.

Instructional Technology: Various technologies are utilized in support of standards-based learning, including computers, graphing calculators, digital cameras, scanners, television studio equipment. In order to have resources available whenever necessary, our technology guidelines (see below) call for equipment in every classroom. We promote the use of online resources for research, communication, collaboration, and problem solving. The student to computer ratio is currently approximately 4:1.

The Springfield Public School District is also a founding district for Massachusetts' Virtual Education Space project (a set of on-line tools and implementation strategies individualized for each educator, student, and parent to enable them to increase student achievement on standards-based curriculum), and has personnel on the Board of Directors and the Working Group.

The district has a system-wide assistive technology team which promotes the concept of universal design for all students throughout the district, and addresses the assistive and adaptive technology needs of our students.

Student Technical Courses and Projects: Springfield offers courses for students in network design and management, hardware maintenance, computer design and animation, telecommunications, CAD, and various other technology/engineering courses with a focus on design and problem solving. Student internships are arranged with local businesses.

Administrative Technology: Every administrator, counselor, and support staff member (where appropriate) has access to a computer and printer which is connected to our district WAN and the Internet. State, federal, and local reports are submitted online by both school and Central Office staff. Professional development on all district software is provided.

The Springfield Public School System is in the process of acquiring SIF-compliant software systems. We have a new student database that interacts with the statewide student information management system, distributed responsibility for data reporting, library automation systems, lunch accountability systems, identification-badge systems, security systems, and a newly designed web site including web pages for each school and program.

Professional Development for Teachers and Administrators: Springfield provides seven full PD days for all teachers each year, as well as 1.25 hours of PD per week. Technology PD is also provided through embedded (on-site, in-classroom) PD, after school and weekend workshops, an on-site Master's Degree program, and online courses.

Our district professional development center includes a 30-station technology training room, multiple small and one large 100-person meeting room, and several classrooms. All are equipped with new technologies for demonstration, display, and hands-on training.

Infrastructure/Hardware/Software: The City of Springfield has committed to replace, renovate, or expand an average of two schools per year until all schools offer equitable services to students and the community. Between 14% and 20% of construction/renovation costs are allocated to technology. Springfield also utilizes grants, bonds, leasing, and E-Rate funding for technology infrastructure, hardware, and software.

All schools currently have Internet access, and twelve schools fully meet the district's technology guidelines (five more are in process):

- School-wide LAN connected to our district WAN
- Fiber-optic connections between communications closets; Category five horizontal wiring to the desktop
- Six networked student computers, one networked teacher computer, and one networked printer in all classrooms
- Computer Labs where appropriate
- Standardized software packages including a productivity package (office suite), software which promotes open-ended reasoning and higher-order thinking skills, and virus protection
- Subject-specific and optional software where appropriate

In order to address the electrical issues in older buildings, we have begun to implement wireless laptop schools, with our first venture a K-5 school. All students and staff will be equipped (Grades 3,4,5 students, and all staff members were equipped in 1999-2000; K-2 students are scheduled to be equipped in 2000-2001) with networked laptop computers.

Partnerships/Collaborations: The Springfield Public Schools considers its business, college, and organizational partnerships to be invaluable. Currently, we partner with organizations such as the Massachusetts Department of Education, other school districts, Mass Networks Education Partnership Inc., TERC, the WGBH Teacher Center, CAST, Inc., the Institute for Community Inclusion, MassCUE, the Northeast Center for Telecommunications Technologies/Springfield Technical Community College, The University of Pittsburgh, Springfield College, Framingham State College, the NSF, Nortel Networks, Dell Computer, LanTamers, Microsoft, Massachusetts Mutual Life Insurance, New Horizons Computer Learning Center, NetSchools, and WGBY Television. All of these organizations, and many others, assist us in providing educational excellence for our students.

Holland Public Schools
Holland, Michigan

Poplar Springs Elementary School
Meridian, Mississippi

Crestwood School/Meridian Public School
Meridian, Mississippi

Farmington School District
Farmington, Missouri

Farmington, Missouri, a City of Tradition and Progress is a rural community located 70 miles south of St. Louis Missouri. The Farmington R-7 School District's current population is approximately 3,500 students with 260 teachers in nine schools. The schools include: W.L.Johns Early Childhood Center (pre K), Truman Kindergarten Center, Washington Franklin Elementary (1-4), Jefferson Elementary (1-4), Lincoln Intermediate Center (5-6), Farmington Middle School (7-8), Farmington High School (9-12), and Midwest Learning Center (alt. sch.). District staff has a strong commitment to use educational technology. The district's technology plan states that Farmington Schools Districts' students will be able to use the tools of educational technology effectively, holding in thier hands the means to shape their own destinies. To accomplish this goal, the district is constantly seeking technology funding which would have the most impact on student learning. To move towards this goal the district participated in the 1999-2000 enhancing Missouri's Instructional Networked Teaching Strategies (eMINTS) Project.

The enhancing Missouri's Instructional Networked Teaching Strategies (eMINTS) project is an expansion of a successful pilot project conducted in six urban school districts which had a high population of at risk students. The purpose of that project was to eliminate the technology barriers, change teaching styles and strategies, and significantly improve student performance. Building upon the success of this project a collaborative effort between Missouri's Department of Elementary and Secondary Education (DESE), Missouri Research and Education Network (MOREnet), and 44 school districts state wide was developed to provide the funding for 88 eMINTS classrooms. Two classrooms, a third grade and a fourth grade in Washington-Franklin Elementary were selected to participate in eMINTS project. Each of eMINTS classrooms have been equipped with a networked computer workstation for every two students, a multi-media teacher workstation, interactive

SmartBoard, data projector, digital camera, printer, scanner, high speed Internet access, and desktop videoconferencing equipment. In addition to the technology available in each classroom, new student desks were designed and purchased. The student desks were ergonomically designed to provide a collaborative workspace for pairs of students. The newly designed desks are visible in the accompanying photographs.

Students after learning the basics on the proper use of the computer and how to access the Internet, pair up in groups of two, view Web sites related to the school's curriculum, use the data projector and SmartBoard, to present PowerPoint and Hyperstudio presentations. This requires the student to think through and evaluate the information they access through the Internet and to define what is clearly important.

To ensure efficient operation of the classroom technologies and appropriate integration of the technologies into the curriculum, the two teachers participated in an aggressive professional development program. This prepared them to use the technologies to support inquiry-based learning and to become facilitators of their students' learning. It also provided them with an understanding whereby the classroom becomes a constructivist learning environment where teachers and students learn and actively participate in the educational process. We as teachers need to become increasingly more comfortable with becoming facilitators (guides and coaches) rather than transmitters of knowledge.

Other positive results of the project have included reduced discipline and better school attendance. Students have also learned independence by finding information on their own, and have gained assurance through their work. Students are taking responsibility for their own education. Not only at school, but at home as well, as many of the student's families are purchasing computers and continuing their education with their families at home.

Robert E. Bartman, Missouri's Commissioner of Education states, "The eMINTS initiative is a key part of the statewide effort to show how cutting-edge technology, in combination with first-class teaching, can transform Missouri's classrooms into the 21st Century."

During the 2000-2001 school year the district has chosen to expand the project into two additional third and fourth grades in the Jefferson elementary school and into a fifth grade classroom in the Lincoln Intermediate Center. A successful passage of a school bond issue in the spring of 2000 will result in a new eMINTS elementary school. All teachers and staff will receive extensive professional development prior to their transfer into this 21st Century school.

Helena Public Schools
Helena, Montana

Helena, Montana, nestled at the base of the Rocky Mountains, is Montana's capital city. The Helena School District, serves 8188 students and includes two high schools, two middle schools, eleven elementary schools, an alternative high school, a transitional middle school and an Adult Learning Center which includes a District Media Center and Technology Training Center. The district employs a well-educated staff of 600. These professionals serve our children, schools and community with dedication and compassion. The Helena Public Schools have a long tradition of excellence in all areas whether it be academics, the arts, technology, or sports. We continue to strive to achieve the Mission of the Helena Public Schools, which is: "...to challenge our students, to maximize individual potential and to help students become a competent, productive, responsible, caring citizens."

A District Technology Plan for the School District was implemented in 1990 and continues to evolve. It is a dynamic document that is revisited and revised. Each school includes a technology component in their Annual School Improvement Plan. Each building's Annual School Improvement Plan must address the role of technology in enhancing teaching and learning. Further, the plan must describe how technology will be acquired and used to maximize improved student learning.

The District established a District Information Services / Technology Administrator position in January of 1998. This position oversees and coordinates the implementation of technology in the District. A network manager position was funded during the 1998-99 school year. This position is responsible for network design, management and security at all levels and for all systems. The District has invested in and implemented local area networks in all schools. All sites are connected in a wireless wide area. Network authentication protocols have been implemented. Instructional applications like Accelerated Reader, business applications, student management applications and library applications are being used District wide.

An Elementary Technology Specialist position was established in 1994 and in 1997 the position also began coordinating activities at Technology Training Center. Library Media Specialists in some locations have accepted responsibility for building level technology support. Both high schools and both middle schools employ a technology teacher. These individuals provide technical support as well as training and instructional support.

The District Technology Training Center was established in the fall of 1996. An extensive Professional Development program was developed and professional development opportunities for district teachers, as well as teachers from surrounding districts and community members, continues today. The Center operates evenings, weekends and throughout the summer months. Non district staff are charged a nominal fee to help defray overhead costs.

All school libraries are automated and provide a wide array of resources both electronic and print which support teaching and learning.

All students and staff in our high schools have comprehensive access to the tools of technology. Access includes classroom, mini-lab, full lab and library lab access. Further all high school instructional sites have both local and wide area network access. The two middle schools and eleven elementary schools have centralized access to network resources and varying levels of access to technology tools.

Each school has a District web site which highlights school activities and student work. Each high school web site also includes instructional information provided by classroom teachers. Email accounts are provided for all staff members.

A set of essential technology skills has been identified at each grade level. Work continues to insure that technology is used as a tool to support teaching and learning and that fundamental skills be used in the context of the curriculum. Efforts at evaluation have tended to be tied to specific programs. The Accelerated Reader Program has been extensively evaluated over a period of five years. Student achievement has been documented through a series of standardized tests, student performance records and other assessments. Students participating in the Problem Based Learning project have provided anecdotal evidence of improved achievement through oral assessments. Additionally, students participated in pre and post assessments which measured their technical abilities.

The Board Policy Committee continues to review and revise technology policies. The Student Acceptable Use Procedure was revised in the spring of 2000. A Staff Acceptable Use Procedure was implemented in the fall of 1999. The Board of Trustees has adopted a Network Policy. Work continues on an electronic publishing policy.

A Technology Literacy Challenge Grant has allowed a systematic implementation of Problem Based Learning at various grade levels and schools across the District. Teachers apply to participate, receive extensive and ongoing training in PBL instructional strategies, and are provided with the technology tools needed to enhance their own instruction as well as enhance student learning. During the second year of the project new participants were matched with a PBL mentor and now in the third year of the project new participants are matched one-on-one with a mentor. Problem Based Learning engages students in solving messy, real-world problems.

The Helena voters approved a seven-million dollar technology / telecommunications levy in the Spring of 2000. This levy will enable the District to implement a new district-wide telecommunications system as well as provide ongoing support and increased access to a wide array of technological tools. Additionally, technology is supported through one-time allocations (i.e. HB47, Timber Technology funds, ERate, etc.). Goals 2000 and Technology Literacy Challenge Grants have helped establish major inroads in the implementation of the District's technology plan.

N

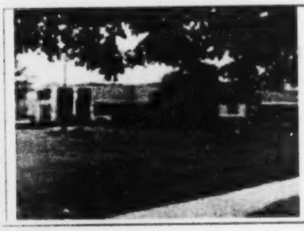
TOP

Grand Island Public Schools
Grand Island, Nebraska

Dodge Elementary School
Aurora, Nebraska

Moultonborough School District
Moultonborough, New Hampshire

Kingsbury Middle School
Zephyr Cove, Nevada



Morris County Educational Technology Training Center
Morris County School of Technology
Denville, New Jersey

Morris County School of Technology is located at 400 East Main Street, Denville, NJ. Since it's inception more than twenty years ago, Morris County School of Technology has been responsive to the needs of the local educational community by researching, developing and providing career, technology and tech prep programs to meet needs not fully addressed in local schools. In the last several years, the school district has been serving as a leader in technology, as a central hub for the provision of technology services, teacher training, and other services that can be efficiently provided through county coordination.

The Morris County Educational Technology Training Center (MC-ETTC) located in Morris County School of Technology is dedicated to providing strategies that integrate technology and education, and provides plans to meet the New Jersey Core Curriculum Content Standards. The Morris County ETTC offers professional development workshops utilizing state-of-the-art technology to unify teaching strategies and technology for all grade levels, and content areas. Training is available on incorporating current technology into instructional strategies. Located at the MC-ETTC is an extensive software library directly related to content areas for our county educators to review.

The MC-ETTC has strong support from all of the school districts in Morris County. Supporting the MC-ETTC is a consortium that consists of 33 public school districts and 20 non-public school districts. To date the MC-ETTC has held 996 workshops for 9,788 educators in Morris County.

The MC-ETTC supports educators in understanding and implementing the New Jersey Core Curriculum Content Standards and the integration of technology across the curriculum through many of our workshops (i.e. *Algebra Two Using Graphing Calculators*, project based workshops, subject specific workshops, and more).

All ETTC's in the state have been certified nationally by the National Association of State Boards of Education as an exemplary educational practice. New Jersey's twenty-one ETTC's meet monthly with the New Jersey Department of Education to stay current with county, state, and federal technology updates (i.e. Universal Service Fund).

Juanita Unhoch, Director of the MC-ETTC brings a unique and diverse background that combines teaching and technology. In addition to writing and winning technology based grants, Ms. Unhoch also provides professional development activities designed to incorporate technology into all classrooms. Mrs. Unhoch earned her Masters of Education at East Stroudsburg University and holds a New Jersey Supervisory Certificate.

Educational Technology Training Center
@Camden County Technical Schools
Sicklerville, New Jersey

To find educational professionals learning to use technology in the classroom, one need not look further than Camden County Technical Schools (CCTS). Camden County Technical Schools operates the Educational Technology Training Center (ETTC) at its Gloucester Township Campus on 343 Berlin Cross Keys Road in Sicklerville, New Jersey. Since opening its doors in 1997, the Camden County ETTC has trained over 8,000 educators, administrators and other staff from schools and municipalities throughout the county.

Three years ago, through a federally funded grant, the State of New Jersey established 21 Educational Technology Training Centers throughout the State, one in each county. The primary goal of this initiative was to provide professional development opportunities to educators in the use of infusing instructional technology into the curriculum.

Technology training is coordinated with statewide initiatives in conjunction with the New Jersey Core Curriculum Content Standards and in the use of infusing instructional technology into the curriculum. The ETTC has four state-of-the-art of training labs, two PC labs, one G4 Apple lab and a distance learning lab equipped with a Concorde PictureTel video-conferencing system and an eight-port bridge. Within the center, there are lab areas dedicated to the demonstration of hardware, software preview and technical assistance.

The ETTC is staffed with a full-time director, technology operations coordinator, a help desk assistant and part-time trainers from our partner schools. The staff development training includes the use of the Internet, graphics, web development, multimedia presentations, spreadsheets, databases, word processing, hand held technologies, desktop publishing, as well as video-streaming, video editing, and video conferencing (distance learning). During the 1999-2000 school year, the Camden County ETTC trained 3350 educators from both public and nonpublic schools throughout the county. Over 96% of the participants in these workshops have rated them to be above average in quality and content.

Camden County Technical Schools also provides space on their server to house the home pages with web site addresses and Internet E-mail addresses for all 162 schools in Camden County as well as access to E-mail for all teachers. This initiative serves over 9,000 students with at least 50% of the 9,000 attending economically disadvantaged districts.

Additionally, each month the ETTC meets with the county school district's technology coordinators. During these monthly meetings, these coordinators receive training on educational technology issues and each meeting culminates with a roundtable discussion of district concerns, as well as, county, state and federal technology updates.

In Camden County, the ETTC has become the focal point of technology for school districts. Every county-based educational technology initiative is coordinated or hosted by the Camden County ETTC. These include the Camden County Technology Committee, the County Technology Curriculum Committee, CAMNET and several other county technology-based committees. The culmination of all of these resources and initiatives serve as a forum and catalyst for the ETTC training programs insuring quality need-based workshops.

Santa Rosa Consolidated Schools
Santa Rosa, New Mexico

Santa Rosa Consolidated Schools (SRCS) consists of five schools in rural Guadalupe County, New Mexico. Guadalupe ranks second lowest in per capita income among New Mexico's counties, and its population has been declining while the state has been experiencing a population increase. Percent of high school graduates in the County is 57.8 compared to a national average of 75.2, and percent of college graduates is 6.1 (national average is 20.3). Average per capita income is $6,529. SRCS is 93.8% Hispanic, and it is ranked first out of New Mexico's 89 districts in "percent of students living in poverty" by Census Bureau statistics. With this demographic data in mind, SRCS has propelled itself to seek excellence in technology education. Our goal is to maximize resources available to our students to prepare them for an increasingly information-driven society which demands technologically-literate members.

Since 1998 the district has had a WAN, with all classrooms, offices, libraries, and computer labs connected. Computers in labs and libraries have direct Internet access through a T1 connection, as does each classroom.

All students and staff members in the district are assigned e-mail addresses. At the elementary level, students are taught keyboarding skills, word processing, and basic Internet search techniques. At the middle school they are taught more extensive productivity skills, more refined Internet search techniques, and basic web page publishing. The high school presently teaches business classes with Office 2000 as the focus of the curriculum.

Distance Education is also important, since the nearest college is 70 miles away. Courses are available by satellite for credit; some classes offer concurrent high school and college credit.

Principal components of our technology program include a very successful student laptop computer checkout program (Internet access provided on the school account), our Distance Education program, after-school and summer enrichment programs, extensive LCD projector use by students (public presentation skills are emphasized), a Technology Plan for Professional Development for staff, and successful community partnerships.

To attain our goal, we are:

- Attempting to fund technology purchases using a variety of sources, including operational funds, mil levy proceeds, grants, and e-rate assistance.
- Providing students with the basic skills and tools they need to succeed in the employment marketplace and in life. We believe that these are: (1) strong skills in reading, writing, mathematics, and communications; (2) a working knowledge of basic computer productivity tools; (3) ability to locate information using Internet resources; (4) basic competency in equipment and software troubleshooting skills; (5) an understanding that cooperation and collaboration are necessary components of successful living and job marketability.

To measure our program's success, we will analyze quantitative data on an ongoing basis. And although scientific analysis is not supported by reliance on qualitative assessment, we also listen to feedback from students, staff, parents, and community members. Based on the initial overwhelmingly positive response we have been receiving, "we must be doing something right".

Des Moines Municipal Schools
Des Moines, New Mexico

The Des Moines School District is located in Des Moines, New Mexico, in the remote northeastern corner of the state. It serves the communities of Des Moines, Folsom, Capulin, Grenville, and the outlying areas. One hundred sixty (160) students are served in the 1,775 square mile district on one campus which includes an elementary and a high school building. Smallness and remoteness have not been a barrier to student achievement; instead, they have been an advantage. The District has been able to provide individualized instructional programs and to ensure participation in activities and leadership development for its students. Now, technology has redefined learning and instructional strategies.

The school system is changing the teaching/learning environment for its K-12 students and, as a community service center, is affecting the lives of community residents in a variety of ways. Change is impacted by a technological infrastructure, a myriad of technology uses, and instructional strategies directed at improving student achievement. The District expects teachers to develop curriculum that is enhanced by technology integration and students to become self-reliant and successful in a new Century that is colored with fast moving technological change. The District's Technology Plan, Educational Plan for Student Success (EPSS) and Master Facility Plan all address technology needs. The fact that distance learning is included in all long-term planning reflects the importance of enhanced education technology and training at school and in the community.

New Mexico's per-student funding formula for technology education might have been the single barrier to development of a successful program. Instead, successful grant-writing and important partnerships have moved the District ahead by "giant steps". In a three-year period, 1996-1999, revenues generated by private foundation grants, Technology Literacy Challenge Fund and Goals 2000 Professional Development grants, and a Rural Utilities Service Distance Learning and Telemedicine Grant enabled the District to place computer work stations at every teacher's desk, establish state-of-the art computer labs, classroom mini-labs, mobile laptop labs, a modern library/media center, and a two-way interactive distance learning classroom. A valuable partnership with the local telephone company resulted in an ideal infrastructure, including fiberoptic cable to both buildings, telephones in each classroom, and unlimited Internet access for students and faculty/staff. In 1999, Family Home and Computing Magazine named the school district one of the "Best Wired Schools" in the nation, based on computers-per-student and Internet access.

In the District, professional development has been the key to ensuring a technology integrated school curriculum. Grant funds, state and nation-wide initiatives, and effective local planning have enabled faculty/staff to participate in a variety of training activities including: RETA (Regional Educational Technology Assistance), US West Teacher Network, site-based staff training, out-of-district visits, conferences, college/university coursework, and curriculum-based initiatives. Des Moines teachers are trainers now and they assist with regional and state-level training programs. District personnel don't still write "technology grants"; they develop curriculum proposals with technology integration (examples: National Geographic Society Educational Foundation Grant, Teacher Dream Fund Grant, MathStar Program, Intel Innovative Education proposals, and various private or educational entity programs.

Most current goals include on-going evaluation of the Technology Plan and student achievement related to technology integration. Recently, teachers designed a K-12 skills matrix that assures sequential skills development with computers, digital cameras, scanners, multi/media presentation, web page design and applications, etc. That skills scope/sequence is aligned with New Mexico Department of Education Content Standards and Benchmarks and National Educational Technology Standards.

Technology has "evened the playing field" for kids in Des Moines and the small, rural school district in northeastern New Mexico has become a leader in educational technology.

Community School District
New York, New York

Community School District Six (CSD6), nationally recognized for it's pioneering and innovative use of advanced mobile computing technology, is located in the Washington Heights section of New York City. It is considered a technological leader among the thirty-two (32) K-8 community school districts in the New York City school system.

This urban, upper Manhattan community is home to a diverse and thriving, but economically disadvantaged, immigrant population. Over 94% of the District's 30,000 student's live at or below the poverty level and nearly 9,000 students are Second Language Learners.

The challenges and obstacles to educating our students and serving our community are many. The unique obstacles created by our commitment to integrate meaningful and relevant advanced technological tools into the day-to-day educational lives of our students are particularly challenging.

In 1996 CSD6 became a pioneer in implementing the concept of parental financial participation as a means of equipping students and their families with the tools necessary to become full participants in the new Information Age. We chose to equip our students with Laptop computers and, in partnership with the Microsoft Corporation and the founders of Connected Learning Associates, created a program that allowed the District and Parents to share in the equipment cost while having ownership ultimately transferred to the parent. This public school leasing model, the first of it's kind in the country, continues to be an integral component in the success of our "Laptop Program".

Our initial 21 student pilot program, begun at our Mott Hall School in Harlem, has been dwarfed by the 5,000 laptops we currently have deployed throughout the twenty-five (25) schools within our district. In varying concentrations laptops are now being used in the day-to-day classroom curriculum in grades four through eight.

This program has made a profound difference in the type and quality of both the student work product and in the student-teacher-parent relationship. Laptop students have also shown impressive improvement in attendance rates and self-image. The unintended increase in Parent involvement in their children's education in general and in attending school activities specifically have become a corner stone of our programs educational impact.

Washington County Schools
Plymouth, North Carolina

Washington County Schools is located in rural, northeastern North Carolina. The county has a high rate of poverty, single parent families, and working mothers. The unemployment rate for Washington County is 6% compared with a statewide rate of 3.1% (Problem-Solving Research, Inc., Business North Carolina, February 2000). Our extremely high rate (70%) of students eligible for free and/or reduced lunch impacts our youth. Our school district, regardless of these statistics, has managed to implement up-to-date strategies using technology in our education curriculum. With the help of Washington County Commissioners, the district was able to lease over $300,000 worth of equipment and software through a lease-to-purchase program, improving our student-to-computer ratio from 11:1 to 5:1. Every classroom has at least one computer with internet access and every school has at least one computer lab for students and staff. All schools have a Local Area Network in place and we have recently established a Wide Area Network for the district.

With the support of Technology Literacy Challenge Fund (TLCF) Grants, Washington County Schools has been able to establish three Teacher Technology Centers at 3 of 5 schools, two Innovatively Challenging Classrooms (one elementary and one high school), and provide technology training through a Technology

Leadership Academy for Teachers and a Technology Leadership Academy for Administrators. Opportunities for technology training are also being provided to support staff and teacher assistants. The Technology Centers contain 14 dual platform computers (Macintosh with PC card or Virtual PC) and various multimedia equipment (scanners, digital cameras, LCD projector, etc.). The Centers are used for staff development and as computer labs for students. The equipment in the Centers is available for checkout so that teachers have access to the equipment for integration into their curriculum.

The Innovatively Challenging Classrooms are model electronic classrooms with 7 iMacs at the elementary school and 7 iBooks at the high school. The elementary ICC Learning Leader uses various software for technology integration. Using problem-based learning activities, the teacher integrates the technology she has available into the third grade curriculum. The ICC Learning Leader at the high school teaches science. The students in her classes use various technology resources to complete projects. She incorporates not only multimedia equipment and computers, but also PBL's and graphics calculators.

The Technology Leadership Academies provide 50 hours of technology training over the course of two school years. Participants must complete a minimum of 27 in-class hours and 23 out-of-class hours. The Technology Leaders in the district provide the training for the in-class hours. There are two individuals at each school who provide on-site technology training and support to their school. For a minimum of 7 hours/month of support and training, they receive a $100 stipend. The in-class training focuses on Word Processing, Spreadsheets, Databases, Multimedia (HyperStudio, Kid Pix, &/or PowerPoint--depending on the grade level), digital camera, scanner, problem-based learning, teaching strategies using the internet, and maintenance and troubleshooting. After the initial 12 hours in the summer or after school (at the beginning of the year), follow-up sessions are offered monthly so that participants are able to complete the 27 required hours. To complete the out-of-class hours, participants must: read journal articles, complete internet research, view technology videos, visit local businesses, and conduct interviews at local businesses or organizations. Participants have to document what they find in each case by answering several questions (i.e. How can you use this info. in your classroom? or How can you share this with your peers?). At the end of the year, participants are required to participate in the Technology Fair (a culminating event for the parents and community). The Technology Fair is where they demonstrate what they have learned as well as allow their students to demonstrate technology-integrated projects they have completed. To receive technology renewal credit, participants submit a portfolio documenting all of their in-class and out-of-class hours, as well as a lesson plan that includes technology integration (for teachers) or a technology-integrated project relative to their area of responsibility (for administrators).

WCS has recently been awarded another TLCF Grant (Year 4) for $75,000 to continue the Academies, continue to provide technology training to teacher assistants and support staff, implement another Teacher Technology Center, and implement another Innovatively Challenging Classroom.

As we continue to implement new and existing technology initiatives, our teachers will become more proficient and our students will become more prepared for technology in the 21st Century.

McDowell County Schools
North Carolina

McDowell County is a rural area in the foothills of the Blue Ridge Mountains of North Carolina. Almost 50% of the county's land produces virtually zero revenue, for it is state or federally owned wilderness or national forest. McDowell County has the lowest per capita and average monthly earnings of the counties along the I-40 corridor across North Carolina. The county is designation 'low wealth,' and its children are ranked 2nd in the state in the percent of medically uninsured. Most parents work in the manufacturing industries.

Despite these seeming barriers, McDowell County Schools have made tremendous efforts to provide the resources, training and infrastructure to make a real impact on teaching and learning. Since the inception of the first district-level technology plan in 1995, many accomplishments have been noted:

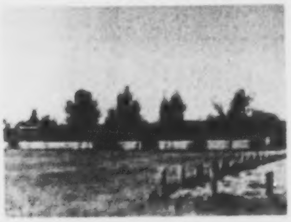
- All regular classroom teachers, grades K-12, have between 1-5 multimedia computers in their classrooms

- All schools have at least one technology lab for class learning
- All teachers participate in at least 30-50 hours of technology-related staff development every five years. These opportunities have moved from skills instruction to work with new ways of developing curriculum to take full advantage of all available resources.
- All elementary and junior high schools have one lead teacher for technology and a full-time technology assistant who serves in both instructional and technical capacities. The high school has a full-time, certified technology coordinator
- All schools have a dedicated Internet connection
- All schools have Local Area Networks, and the Wide Area Network is in the final stages of implementation
- All teachers and administrators, along with many support personnel, have email and use it for daily communications.

These accomplishments have been made possible not only through a strong commitment from local school administrators, but by a number of business and community partnerships. Grant funding has also been instrumental in the progress of the instructional technology program. Partnerships and funding sources include:

- A local hardware vendor which provides three-year, on-site parts and labor warranty support
  A software vendor which provides staff development and technical assistance at no cost to the school system
- A Regional Education Service Alliance which provides technology training and consulting support
- A regional consultant from the Department of Public Instruction who works as an aid in all facets of the program
- Technology Literacy Challenge Grant Funding
- Universal Service Fund discounts.

As the next technology plan, for the years 2001-2005, is written at both school and district levels, provisions will be made toward constant and continuing improvement of technology infusion in the schools. Curriculum development, infrastructure improvements, and improved use of technology to communicate with parents and community will be important parts of these efforts.



Richardton-Taylor High School
North Dakota

Richardton-Taylor High School is located in the small rural community of Richardton in Western North Dakota with an enrollment of approximately 190 students from grades 7-12, and a staff of approximately 20 teachers. Taylor-Richardton Elementary in the rural community of Taylor enrolls 180 students from grades K-6.

Teachers and students have access to technology in many forms, including a 1:3 computer to student ratio in computer labs and mini-labs located throughout the classrooms. Networked laser printers, color laser and inkjet printers, digital cameras, flatbed scanners, video cameras, in-focus projectors, laptops, graphing calculators and palm pilots are accessed daily by students and teaching staff. Extensive research is available to all students and teachers through the use of on-line subscriptions to Electric Library, encyclopedias, Microsoft Reference Encarta and other on-line services. Curriculum in the technology area is strong in applications as well as technology education in robotics, mechanical drawing, CAD programs and many more. Curriculum is constantly revised and revisited, and in the fall of 2001, programs in A+ certification and Cisco Training will be provided to students

Over the course of eight years, the school district has established a local area network within the building. A network administrator is hired to establish and maintain the LAN infrastructure. Microsoft NT with a domain server and Windows '95 and '98 on all workstations is the major network software applications throughout the school. Internet connections, a registered domain name, domain servers, a local web server (http://www.richardton.k12.nd.us), an Internet mail server and dial-in access are established. E-rate dollars have been used over the past three years to help support and provide Internet and intranet applications, as well as hardware needs to maintain the network. All teachers integrate technology through the use of a variety of on-line applications software to record student attendance, school correspondence, grading, create presentations, e-mail and Internet access. Administrative software is used for all scheduling, accounting and maintenance of student records.

Staff development opportunities are available throughout the year for all teachers. Teachers have received local training over the last three years in creating and maintaining local web pages to integrate technology in their day-to-day curriculum. Teachers receive stipends to attend and present at the State Teaching and Technology Conference (TNT) for one week in June in the capital city of Bismarck. Teachers are funded and encouraged to attend and present at many state and national conferences.

An appropriate amount of release time during the school day has been provided for 100% of the teachers as a result of grant dollars available through the North Dakota Teaching With Technology (NDTWT) grant and competitive Federal Challenge Grants available through the Department of Public Instruction in ND. The North Dakota Teaching with Technology Initiative (NDTWT) is a five-year project to integrate technology into the teaching curriculum in North Dakota public schools. The initiative was made available by a federal 1998 Technology Innovation Challenge Grant Award, which provided for 20 grants at a total of $7.3 million over the five years. Its audience is the school administrators, teachers, and other educators. The goal is to provide training and technical assistance that will enable educational staff to effectively integrate technology as an instructional tool into the curriculum. The Richardton-Taylor School District will continue to actively participate in this grant for the next three years.

SENDIT Technology Services
Fargo, North Dakota

O TOP

New Albany High School
New Albany, Ohio

Pickerington Junior High School
Pickerington, Ohio

S

TOP

Isabel School
South Dakota

Isabel, a town of 280 people located in a geographically remote portion of northwestern South Dakota, borders both the Cheyenne River and the Standing Rock Sioux Tribe Reservations. In this mostly agricultural area, lies a single school district-- a self-contained K to12 school with approximately 140 students from 3 counties. All elementary teachers have a classroom with 2 grade levels combined. 47 students attend the high school. About 70% of the students qualify for free and reduced lunches and 30% of our students are Native American.

The entire school is networked under Governor Janklow's "Connect the Schools" Program. Each classroom has at least two computers connected to the Internet, although many classrooms have multiple connections. Keyboarding instruction begins in the elementary grades. There is a 14-station networked PC lab in the high school and a 14-station networked iMac lab in the library. The iMac lab, funded by school-wide Title I and Title VI, offers computer-assisted and individualized math and reading instruction to all elementary students daily. A V-TEL distance-learning studio will be functioning during the 2000-2001 school year, allowing students to enroll in selective courses offered throughout the state and to collaborate with other classrooms.

Small class sizes and low teacher-pupil ratios encourage individualized and personalized attention. These improve the availability of our highly dedicated teachers and create unique opportunities for parents and school staff to partner to maximize student potential. A Goals 2000 Technology Planning Grant during 1996 and 1997 was evidence of the power of collaboration between school and community. These relationships create high standards and expectations for all students, and ensure that the school maintains the community's values. The effectiveness of this model is demonstrated by the fact that Isabel students consistently perform above state norms on standardized testing. 99+% of the district's students graduate from high school, 58% go on to college and 20% enter vocational education programs.

The past decade has witnessed a two-pronged educational emphasis within the school. In addition to teaching "the basics" there has also been a focus on problem solving and applications in math and science. As a result our students have rated highly in regional History Day, Science Fair, and Quiz Bowl competitions and advanced to National History Day and International ISEF Science competitions. Inclusion in the TEC-RAM Federal Challenge Grant in1998 and the LOFTI Federal Challenge Grant in 1999 has allowed for intense professional development for Isabel School's educators over the past 2 years. Opportunities to expand their expertise and knowledge have profoundly impacted the education of our students. With the availability of equipment and training, not only in technology, but also in new teaching techniques and assessment methods, our students are learning in technology-infused, engaged-learning classrooms.

Britton School District
Britton, South Dakota

The Britton School District 45-1 is a K-12 district with an enrollment of 530 students. There are three facilities in the district: one elementary school (K-6), and a junior/senior high school (7-12) are located in the city and one elementary school (K-8) is located at Sunset Hutterite Colony seven miles west of town.

The Britton Elementary School provides two sections of each grade as well as special education and related services. It has a full time staff of 19 teachers, three certified aides and two non-certified aides. The population demographics are similar to most rural South Dakota communities. The majority of students are Caucasian of northern European ancestry. However, the number of students who are from a non-traditional background is increasing every year.

The Sunset Hutterite Colony has a rural school with approximately 30 students in grades K-8 taught by two certified teachers and one non-certified aide.

The Britton Junior/Senior High School had an enrollment of 250 students in 1999-2000 with 17 certified teachers and one non-certified aide. The high school, with a tradition of academic excellence, has been accredited by the North Central Association since 1927.

In the past five years, approximately 90% of the high school graduates have elected to attend a university, college or vocational school. The student body boasts a 95% attendance rate and a 95%-100% graduation rate.

The Britton School District 45-1 is a rural district in northeastern South Dakota. The district includes the communities of Britton, Lake City, Kidder, and Amherst and totals 444 square miles.

The school district is a state leader in technology. It is one recipient of a federal grant, LOFTI, which targets staff technology development and integration of that technology into the curriculum. A large majority of the staff works vigorously at mastering new technologies and teaching those skills to students. Staff development opportunities are available throughout the year for teachers. LOFTI committee members and TTL (Technology for Teaching and Learning) graduates teach the classes.

District infrastructure includes internet drops in every classroom, a workstation by every teacher's desk and a 1:2.5 computer to student ratio throughout the district. Two computer labs in the high school and one lab in the elementary school are easily accessible and used hourly by classroom teachers. All computers are networked and the school is connected to the internet by a T-1 line.

Britton, the county seat of Marshall County, serves as a trade center for part of northeastern South Dakota. It is located in the heart of the Glacial Lakes area and provides easy access to fishing, swimming, skiing and camping. Historic Fort Sisseton is located within 25 miles of the city and the annual Fort Sisseton Festival draws hundreds of visitors from several states.

Britton is a unique small town in that it has three thriving industries including: Horton Industries, a very successful high-tech fan clutch plant which employs over 200 people; Sheldahl, an electronic plant which produces electronic circuitry for major businesses such as Delco, IBM and Boeing, and which employs 125 people; Truss Pros, one of the largest truss/rafter companies in eastern South Dakota and which employs over 75 people.

In addition, Britton has a successful hospital/clinic, including a new assisted living center, a nursing home, a dentist, a chiropractor and a vital business district. All look to the school for leadership and training in technology.

T

SUPERNet Districts

East Texas

Eyes wide with anticipation, 122 new adventurers (teachers) embark on Voyage of Discovery II. Representing the 2316 teachers and 28,850 students of the fifteen SUPERNet districts of East Texas, the anxious voyagers look forward to joining their predecessors. Stories of success from those who blazed the trail last year have spread throughout the districts creating an air of excitement that makes systemic change appear to truly be within reach. The new world promises hope of a brighter future where all students are designers of their own destiny.

The way has been paved by the 128 trail blazers of Voyage I. As the new voyagers set sail, the security of the network of support woven throughout the consortium allows them to step out into risky territory. It is this network which is the single most important factor for enabling change to be sustained. Previously isolated in time and space, sojourners now know that they are not alone in the change process. Imagine a land where students initiate projects, use technology to solve problems, and work collaboratively to accomplish real world tasks. Teachers confidently guide their exploration, totally in control of the direction of instruction, while modeling the joy of lifelong learning as they share in their students' discoveries. Imagine students who seek out other students via electronic means, using voice, data, and video; teachers who collaborate electronically, and community members who share in the desire for their children to have these opportunities. Due to the TIE 4 expansion grant it's happening!!!

- 13,178 hours extra duty time put in by teachers in the last 9 months learning technology
- Over 250 community members in 13 districts participate in summer tech school
- 15 districts use distance technology to train inservice teachers monthly
- 15 districts unite their community members by distance technology
- Over 1700 PowerPoint presentations created by project teachers' students
- Over 500 webquests created by project teachers and their students

As these bold explorers embark, (Arp, Big Sandy, Carlisle, Chapel Hill, Hawkins, Henderson, Jacksonville, Lindale, New Summerfield, Tyler, Union Grove, Van, Whitehouse, Winona, Winnsboro) they will be joined by many fellow dreamers. The Southwest Educational Development Laboratories will keep the vision alive and always progressing. Local partners, The University of Texas Health Center at Tyler, Tiger Missing Link Foundation, The Discovery Science Place, The Literacy Council, and The Athens Freshwater Fish Hatchery, will join the journey and lend their special resources, making the dream a reality. Local captains (principals) will ban together to assure that proper credit for efforts made is given. Their collaborative charting of a clear direction for the journey is an essential goal to be accomplished this year. The resource monitors (librarians) will work together to create an environment supportive of the new structure. And most importantly, the support network built last year will serve as a constant safety net as the new adventurers step onto the tightrope of change. As last year's travelers become this year's leaders, they will use technology to implement the constructivist model in the classroom which will broaden the horizons of learning for hundreds of East Texas students. Last year's successes are already evident and enthusiasm is spreading like a tidal wave to new voyagers in the 15 districts.

Cyberways & Waterways

Texas

Cyberways and Waterways integrates technology and education by means of an environmentally based curriculum centered on Texas' streams, rivers, coastlines and oceans. Through the creation of a unique public-private sector consortium, Cyberways and Waterways brings together the best of the best in education, technology, marine and aquatic science, and the private sector to deliver a high profile program for all participating schools. This innovative online and field study learning program offers students and teachers an unprecedented opportunity to study and electronically visualize the entire Texas watershed from school grounds, streams and rivers to the Flower Gardens coral reef 110 miles off the Texas shore in the Gulf of Mexico.

Students become technically literate as they develop interdisciplinary real-world skills such as data analysis, graphical presentation, interpretation, critical thinking, and information synthesis using the environment as a contextual framework for learning. The Cyberways and Waterways curriculum, website, resource material, and online chats are fully bilingual (Spanish and English) to ensure that all students, parents and teachers derive maximum benefit from the program.

Funded by a grant through the Texas Education Agency, Cyberways and Waterways directly involves over 50,000 students in participating school districts. An average of 59% of students are economically disadvantaged. The ethnic diversity of the target student population is 58% Hispanic, 30% Anglo, and 12% African American. Cyberways and Waterways will indirectly include more than a million people through consortium member organizations, as well as the nearly limitless population of the World Wide Web.

Cyberways and Waterways Consortium

The Cyberways and Waterways consortium is comprised of over 30 schools and over 30 public, non-profit, and private organizations. Consortium members include:

Texas School Districts
Along the Colorado River: Austin, Brownwood, Colorado City, Palacios, Van Vleck
Along the Rio Grande River: Brownsville, Del Rio, Eagle Pass, Laredo, Presidio, El Paso
Along the Brazos River: Round Rock
Along the Trinity River: Dallas, West Hardin
Along the Nueces River: Odem-Edroy
Along the Neches River: Kountze,
Along the San Antonio River: Northside SA
Along the Sabine River: Little Cypress

Education Partners
Charles A. Dana Center at UT-Austin
Texas AandM-Corpus Christi - Center for Coastal Studies
Texas Center for Educational Technology
Texas Education Agency
T-Star Studios

Marine and Aquatic Science Partners
Adopt-A-Wetland Program
Center for Marine Conservation
Coral Reef Alliance

Marine and Aquatic Science Partners (cont.)
National Oceanographic and Atmospheric Administration - Flower Garden Banks National Marine Sanctuary
Gulf of Mexico Foundation
Lower Colorado River Authority
Secret Sea
Texas Natural Resource Conservation Commission
Texas Parks and Wildlife

Technology and Business Partners
America Online's Digital Cities
Capital Area Training Foundation
4empowerment.com
IBM
M-Pen
Talk City
Terrace Mountain Systems

Cyberways and Waterways was conceived by 4empowerment.com. 4empowerment.com was founded with a vision to make a positive difference in the lives of individuals, the community, and the environment. Steve Amos, President and Founder of 4empowerment.com, brings extensive expertise in both the technology and business sectors. During his 20 years in marketing and advertising (both domestic and international), Steve created successful online campaigns for the Tourism Division of the Texas Department of Economic Development (winner of a 1997 CASIE award for website and online advertising campaign), the Center for Marine Conservation, MasterCard, Wal-Mart, Southwestern Bell Cellular, Lennox Industries and other business clients.

Science Academy of Austin at LBJ High School
Austin, Texas

Lindale High School
Lindale, Texas

U

Grand County School District
Moab, Utah

Grand County School District (GCSD) is a rural school district located in Moab, Utah (SE Utah). We serve almost 1600 students in grades K-12 attending one high school, one middle school (grades 7-8), one intermediate school (HMK, grades 4-6), and one elementary school (RRE, grades K-3). We also have an adult education center and a preschool (CRS).

Networked Schools
All GCSD schools are networked and connected to a wide area network. We have thirteen servers (two Windows NT, one UNIX, and ten NetWare 5.1) using a star-bus topology, Ethernet protocol, and Cisco or LinkSys routers and switches. Each school has a fiber backbone and 100 Mb connections from the workstation to the backbone. Each elementary school has one instructional computer lab, a mini-lab in the library, and at least one computer in each classroom. Secondary schools have up to five instructional computer labs, a lab of twenty computers in the library, several mini-labs, and at least one computer in each classroom. We manage our own e-mail, mailing list, and DNS servers. We also provide free, dial-up access to the Internet for all district employees. Our district network is part of Utah's Education Network.

Hardware and Software
We have fifteen Macintosh computers in the Special Education classrooms. Remaining computers are Pentium-level computers running Windows NT on the desktop. Our computer-to-student ratio is 1:4. All Wintel computers have direct connection to the Internet and are running both Netscape and Internet Explorer browsers. We also have site licenses to Microsoft Office 2000 and SIS 2000+ (administrative software using Microsoft SQL server). This school year, we will be installing a Web interface to our grading and attendance software so teachers can work from home and parents can access their student's current grade, homework, and attendance information.

Professional Development
Our district has been very active in providing both online and in-person professional development opportunities for all district employees. We were the recipients of a Technology Literacy Challenge Grant for Professional Development in 1999-2000. It is our goal to create online agendas and references for all professional development courses so teachers can refer to the information when needed. Please visit our Staff Development Agendas and our Frequently Asked Questions pages.

Curriculum Integration
Our instructional support and staff development focus over the past two years has been on Curriculum Integration of technology. We believe we have an excellent installed base of hardware and software, a good mechanism in place to update that hardware and software, and progressing plans to integrate the technology

into the teaching and learning process. Please visit our 102 Tips for Technology Integration page (a new project still in progress) for more information about how we use technology in Grand County School District.

Support
We have four, highly-qualified staff members providing technology support: a Technology Coordinator who also teaches networking, programming, and computer repair at the high school (she has Novell CNA/CNI and CompTIA A+ certifications and a teaching certificate with computer science endorsements and an administrative credential); a District Sysop who provides user support (he has a Novell CNA certification); and two network technicians (one is a Novell CNA and the other has both Novell CNE and Cisco CCNA certifications). Our Technology Coordinator is also the President of the Utah Coalition for Educational Technology, an affiliate of ISTE, and serves on Utah's Information Technology Core Curriculum Executive Committee. Please visit our Technology Support page for more information about the support we provide.

Awards
Grand County School District was selected by the Ohana Foundation as Utah's recipient of the Technology in Education Leadership Award for 2000.

V

Lamoillel South Supervisory Union
Morrisville, Vermont

Hanover County Schools
Ashland, Virginia

W

Mount Baker High School
Deming, Washington

Mt. Baker School District is a semi-rural district in northwest Washington State that educates approximately 2500 K-12 students. The district has 3 elementary schools (K-6), one junior high school (7-8) and one high school (9-12). All classrooms and offices in the district are connected via LAN and also contain multiple connections to the Internet. The district utilizes 3 servers that provide for administration, staff and student file sharing capabilities and independent work. The district also employs one network supervisor and two technicians for classroom support. The district has been an aggressive recipient of technology grant funds for the last 5 years-securing about $2.1 million in competitive monies from state and federal sources. Mt. Baker Science Department has been recognized nationally for its creation of a digital curriculum and featured in CNN News segments and Apple Computer Marketing videos. The district wishes to develop a comprehensive technology and content-based standards curriculum framework with assessment tools.

Sherman Junior High School
Seth, West Virginia

Oconto Falls School District
Wisconsin

The Oconto Falls School District, located in rural Northeastern Wisconsin, stretches forty miles from the cool waters of the Bay of Green Bay at one corner to the edge of wooded lands of the Nicolet National Forest at the other. This is a school district which includes a mix of dairy farms, a state of the art paper mill, an active industrial park, and a divided four-lane highway used by many residents on their daily commute to work in the Green Bay Area. This same road fills with weekend traffic as people living further south head to weekend cottages and vacation spots in the north woods.

The district has just under 2,000 students in six different schools including a multi-graded two room rural charter school and a high school alternative charter school. The district was a pioneer in the use of CAD systems and partnered with IBM as a Beta site for their software over ten years ago. The rural nature of the district limited its access to the world wide web. The first access to the Internet was through dial up long distance lines. Today the district has a wide area network connecting four sites with fiber and a fifth with a T-1 line. The district has made good use of state funding opportunities such as TEACH and WATF. An important partnership is with the City of Oconto Falls which uses fiber to carry video signals from the Oconto Falls High School to the local cable access channel.

A significant catalyst for change in the use of technology came with the formation of the TRITON distance learning network in 1994. This network brought together nine rural school districts, a technical college and St. Norbert College. The initial goal was to allow the members to provide instruction between the sites through interactive full motion video. Through this medium, the rural districts would not just survive, but thrive. The network became fully operational in August 1996. It soon became apparent that TRITON was much more than distance learning. In the second year of operation, a grant brought high speed Internet access to each of the schools. Training has an important part of TRITON. The network received a number of grants to train teachers who were instructors on the network. In August of 1997 the first TRITON Totally Technology Academy at St. Norbert College. This was a week long residential training for teachers and was very well received. Many of the participants went on to become change agents in the use of technology within their own school districts. This format allowed teachers to participate in high quality training without the distractions that might come if the training was in a short after school session in a local school building. The fact that the Packers training camp was headquartered at the same location was an added bonus. The academy has grown during each of the four years it has operated.

During the 97-98 school year TRITON received the first of four TLCF grants. Each used a slightly different approach , but a project funded mentor was key to the success of the effort. The TLCF projects had active participation from the private schools in the member districts. The 99-2000 project brought together several concepts with a focus on the Wevfolio. The latest project will develop and support building level technology mentors.

The summer of 2000 saw the first participation in a new masters degree program set up in partnership with St. Norbert College. The format allows teachers to complete much of the program through the TRITON network from their own school buildings.

The success stories of the Oconto Falls School District and the TRITON network during the past five years have made it clear that rural school districts have not only kept pace, but have taken a leadership role.

Platte County Schools
Wyoming

In 1995, Platte County School District Number One in Wheatland, Wyoming, began Project PLATTE.LINK, an ambitious seven-year technology integration initiative. In spite of the high availability of technology and Internet access in Platte County, professional development efforts had not prepared teachers to thoughtfully integrate educational technology into the curriculum. To address this concern, District administrators formed a cadre of teacher-trainers to become the District's "Technology Integration Team." The team of thirty K-12 educators has been trained to help other teachers integrate technology into their specific curricular areas. This team has also fostered staff development and technology integration among a number of school districts and institutions in Southeastern Wyoming.

Platte County School District Number One had long known that well-trained teachers are the keys to successful classroom technology integration. District administrators had also known that technology-savvy teachers would use computers as tools to provide enriched learning environments. However, to move from technology novices to true innovators, the District realized that educators must learn in an active process in which the learners (the teachers) are full participants. As a result of this integration project, this cadre of educators in recent years has explored the viability of technology in education, learned to model "best practices" for colleagues and has explored critical questions that face the district as technology continues to advance.

Much of the training for the Technology Integration Team has occurred over the Internet in the form of Web-based instruction in productivity tools (phase I training). As part of this staff development program, teachers are trained on industry-standard applications in a self-paced, non-threatening environment. This program enables teachers to determine their current level of knowledge on selected computer applications, participate in on-line training modules and complete a certification test at the end of the project. During the second phase of this program, participants focus tightly on the curricular implications that technology poses for today's classroom. This training has included:

- Customized, facilitated workshops that support the integration of technology into the classroom, performance-based assessment with rubrics, meeting the needs of divers groups of students, constructivist methodology, and learning-centered classrooms
- Sustained, small group mentoring sessions in the schools that reinforce the strategies and techniques introduced in the workshops.

Since its inception, Project PLATTE.LINK has made a positive impact on education in this rural Wyoming school district. According to one outside observer: "The team of teachers and administrators has made significant strides in effectively integrating technology within their existing curriculum. They have embraced pedagogical and philosophical issues relating to constructivist teaching approaches, learning-centered classrooms and multiple assessment methods. This has facilitated meeting the needs of students with varied intelligence and learning styles, and incorporates all the elements of effective planning, preparation, instruction, management and assessment."

Campbell County School District
Wheatland, Wyoming

ED HOME EDTECH CONFERENCE 2000 *This page last modified September 7, 2000 (bay).*

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Campbell County School District
Wheatland, Wyoming

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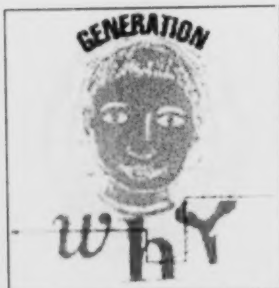
The Secretary's Conference on Educational Technology 2000

DEMONSTRATION PROJECTS

Cognitive Tutor Math Program
Fox Chapel High School and Carnegie Learning

Exhibitors: Kristine Yacamelli (Fox Chapel High School), Dr. Shelley Beck (Fox), Sheridan Wessel (Fox), William Hadley (Carnegie), and Robert Janosko (Carnegie)

Fox Chapel Area High School has been incorporating Carnegie Learning Math for the last five years as a way to address various learning styles and differentiate instruction in the flexible block schedule. Functional Algebra I, Functional Geometry and Functional Algebra II are the three courses taught in the eighty minute classes using the CarnegieLearning Math Program. The instructor dedicates forty minutes of the eighty minute class to teacher-guided instruction and forty minutes to computer-based instruction where students complete a self-paced tutorial (Cognitive Tutor). This tutorial is designed to reinforce the material covered in the lesson, provide customized instant feedback, address problem areas and provide problem situations that apply to everyday life. Approximately 1/5 of the underclass student body is enrolled in either the Carnegie Learning Algebra I, Geometry or Algebra II courses for the 2000-2001 school year. The large number of students enrolled in these courses realize that this alternative approach integrating the computer component and varied pacing of the curricula/activities provides opportunities to master the mathematical topics. Experienced math teachers in Fox Chapel Area High School who teach both traditional math courses and the Carnegie Math courses note that students who struggle in traditional math settings have more of an opportunity to be successful in the Carnegie Learning System. One hope for Fox Chapel Area High School teachers is that the students enrolled in the Carnegie Learning Math Program will have the necessary skills and background to be successful in the math portion of the PSSA (Pennsylvania System for School Assessment) in 11th grade. This statewide assessment asks students to focus on their knowledge of the Pennsylvania math standards. It also checks school progress toward meeting those standards. To support this effort members of the math department have researched additional supplemental lab opportunities for students and included alternative assessments that relate to real-life scenarios and standardized math exams.



Generation www.Y: Students as Change Agents

Exhibitors: Dr. Dennis Harper, Ryan Powell

Generation www.Y is an integrated model for delivering job-embedded professional development to teachers while providing students with opportunities for engagement and leadership in their schools and communities. The model promotes a learning community approach to education, in which students and teachers work together to create and deliver updated, technology-enriched lesson and unit plans aligned to state and local standards. The Generation www.Y class is delivered as a regular elective or as an extracurricular activity in grades 4-12, and can be adapted for varying levels of background expertise as well as for specific local hardware and software infrastructures. Much of the work is centered around dyads -- partnerships made up of an individual partner teacher and an individual Generation www.Y student. This allows the project-based learning to be tailored to meet the particular needs and interests of these individuals. These teams are engaged in meaningful, useful work: creating curriculum materials and lesson plans that are used by other students in the classes taught by the partner teacher. Teachers learn to integrate technology by doing what they would normally do -- update their lesson plans -- with personalized support and assistance for the integration of technology in their curriculum units. Students become involved in creating their own schools, and gain experience doing authentic educational work as a valued team member. Generation www.Y is now being delivered in hundreds of schools throughout the United States.

SBHS Imaging Lab

Knower's Ark...Creating Spielbergs in Vermont

Exhibitors: Tim Comolli, Keelan Finnigan, David Petricola, and Todd Richard

If you've seen the antics of the animated M & M's selling chocolate on TV, the gyrating Fox television logo, or the witty 3D characters in Toy Story, then you know what we do in the Imaging Lab at South Burlington High School. Hollywood has made much of the phrase "...build it and they will come". At South Burlington High School the phrase has proven to be more a reality than fantasy. Indeed, the creation of a student supported and operated graphics lab has become the catalyst for the implementation of a wide variety of technology initiatives throughout the community. This nationally recognized program uses animation and graphics as a "hook" to get both community members and kids involved with advanced technology. The Imaging Lab at South Burlington High School began as "one computer in the back of the room" and has grown into a state-of-the-art computer graphics facility. The Lab has raised over a half-million dollars from gifts, grants, and the sale of student products. Students utilize the same programs that were used in the making of Titanic and Star Wars: The Phantom Menace. Kids now create on high-end Intergraph and SGI workstations.

Montgomery County Public Schools' Core Staff Development Models

Exhibitors: Liz Glowa, Bonny Chambers, Nancy Carey, Rafael Gramatges, Cathy Elliot

The Early Childhood Technology Literacy Project (ECTLP) provides opportunities for pre-kindergarten through second grade teachers, specialists and instructional assistants from Title I schools to develop, plan, and deliver exemplary reading and writing instruction that infuses technology into early childhood educational experiences. The instructional focus of the project is to increase reading and writing achievement while supporting Maryland Reading Language Arts Outcomes and reaching the Montgomery County Public Schools (MCPS) goal that every student read independently by the beginning of third grade. Two Early Childhood Technology Specialists provide staff development enabling teachers, specialists, and assistants to develop the skills needed to integrate technology into exemplary reading/language arts instruction. Additionally, ECTLP connects the classrooms of participating teachers to the wide area network and provides hardware and software to Pre K-2 teachers and students.

The C5 Project: Children Connecting Classrooms Community Curriculum

Exhibitors: John Bennett (teacher), Karen Grindall (teacher), Colin Grindall (student), Mrs. Jordan (parent), Brittany Jordan (student), Usama Taugir (student), Megan Holmes (student), and Dezmond Carlton (student)

Once the school of the elite of Akron, Portage Path School of Technology, at its age of 92, now serves an urban population of mainly lower class working families. The staff has not let the age of the building nor the limited economic capabilities of many of the parents stop them from helping the children become connected to their electronic world. Over ten years ago, after winning an Apple Crossroads Grant, Portage Path was the first school in the area to network its building, something that most businesses had not even started doing. Today Portage Path School of Technology is not only networked with Time Warner's Roadrunner high speed internet access but it is in a partnership with Time Warner to provide the same high speed access for families at home. Two teachers created a program called the C5 Project (Children Connecting Classrooms Community Curriculum).

CAST

Universal Design for Learning: Preparing Media for Supported Learning

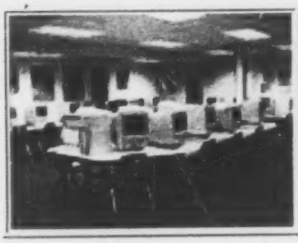
Exhibitors: Nancy Schick and Michael Cooper

eReader adds spoken voice, visual highlighting, document navigation, or page navigation to any electronic text. The software can take content from any source-the Internet, word processing files, scanned-in text, or typed-in text-and combine it with the most powerful features of talking and reading software. CAST eReader makes text-based materials accessible to everyone and is particularly beneficial for children and adults who have reading or learning disabilities, read below grade level, speak English as a second language, have low vision, or have certain mobility problems. Teachers and students use eReader to gain access to material from textbooks, exams, worksheets, notes, reference works and literature; students can also create text in the program and receive spoken feedback as they work. Many language arts and writing teachers use eReader to enhance their students' writing skills because the read-aloud language supports the written word.

Interactive Multi-Media Exercises (IMMEX) Project
University of California at Los Angeles

Exhibitors: Dr. Ron Stevens, Dr. Joycelin Palacio-Cayetano, Dr. Marcia Sprang, Terry Vendlinski, Jennifer Underdahl, and Tricia Um

IMMEX (Interactive Multi-Media Exercises) is a dynamic computer software-based learning and assessment tool designed to foster problem solving, integrative learning and meta-cognitive reflection in many disciplines and across levels of education. For the past eight years the IMMEX Project at UCLA has been developing frameworks for the classroom integration of problem solving technologies which provide guidelines for teacher-directed authoring of problem-solving software, for effective curriculum/software integration, for the implementation of technology for learning and assessment, for data analysis and reporting, and lastly, for development of models of student learning.



Mantua: A Basic School Powered by Technology
The Vision Continues

Exhibitors: Sarah Skerker, Patricia Small, Kim Dockery, Betty Dunning and Mantua Students

Mantua Elementary School has launched the third year of its award-winning program, Mantua: A Basic School Powered by Technology. Located in Fairfax County, Virginia, Mantua Elementary is home to a diverse student population of 850 general education, deaf, English as a second language, gifted, and learning disabled students. Highlights of this exhibit will include recent technology integration and performance assessment accomplishments, and student demonstrations.

One Sky, Many Voices
University of Michigan and Detroit Public Schools

Exhibitors: Nancy Songer, Deborah Peek-Brown, and a Student

Through One Sky, Many Voices, over 11,000 largely urban middle school students and teachers have collaboratively studied current storms, hurricanes, and other atmospheric science events. The curriculum is a flexible shell of four or eight programs, tailored to support the National Science Standards, which contains "core" activities that every site is expected to enact at approximately the same time so that they can share and coordinate work products. Software tools include an Internet browser for retrieving current weather and environmental science data and imagery, archived imagery and movies, and web-based message boards.

iEARN

International Education And Resource Network (I*EARN) In The Primary Classroom: Launching Literacy Essential Learnings Through Local to Global Collaborations Around the World and Across Curricular Content

Exhibitors: Kristi Rennebohm Franz, Jennifer Ann Widman

The International Education and Resource Network enables young people to undertake projects designed to make a meaningful contribution to the health and welfare of the planet and its people. I*EARN has facilitated educational and development projects since 1988, pioneering an "interactive" approach to using educational technology by encouraging students to actively contribute to, rather than just passively "surf," the Internet. Initial pioneering programs were created in the US and former Soviet Union to demonstrate that telecommunications technology can both enhance learning and create on-line global communities. I*EARN provides the teacher-designed content and interaction to answer the question "Now what?" after a school has access to the Internet. To support its projects abroad, I*EARN creates centers in the countries in which it operates, often within the Ministries of Education or other educational or youth-service organizations. After establishment, I*EARN programs in each country have become self-sufficient using local resources within one or two years. I*EARN is a 501-c-3 not-for-profit corporation, incorporated in the State of New York.

PiCoMap

Palm-based PicoMaps To Internet-based Snapshot Surveys: Leveraging Emerging Technologies for Learning & Teaching Center for Highly-Interactive Computing in Education (Hi-CE)

University of Michigan In collaboration with the Texas Center for Educational Technology (TCET) University of North Texas

PiCoMap is a concept mapping application for PalmOS organizers. This project was conceived by the University of Michigan's Highly Interactive Computing in Education group (hice) for use in middleschool classrooms, but might also be useful for a much wider range of applications (business, systems analysis). PiCoMap provides a simple interface to describing a limited number of objects (16 at a time, for this demonstration version) and relationships between them by sketching bubbles, lines, and labels. Integrating networked, computational technologies in K-12 classrooms is the most challenging education innovation in the last 200 years. We are asking teachers and administrators, schools and school districts to make fundamental changes in their pedagogical practices. Rather than relying on information transmission instructional strategies - strategies that have been in use for over 50 years, but which are clearly not enabling children to achieve at the desired level - educators need to adopt an inquiry pedagogy, where children investigate driving questions of their own construction.

Akatsuki Academy

Fulbright Memorial Fund
Master Teacher Program
Japan - United States Educational Commission

Exhibitor: Kyoko Jones

The core of the Master Teacher Program is sharing collaborative learning activities. The program strives to involve students and teachers as much as possible in working together with each other, and technology is the tool that makes this happen. Naturally, the perfect technology would be a teleport that would bring students right into each others' classrooms. However, it hasn't been invented yet. The Fulbright Master Teacher Program uses other technologies such as e-mail and the Internet to bring students and teachers in different countries closer together.

iste

International Society for Technology in Education (ISTE)
National Technology Standards for Teachers

The International Society for Technology in Education (ISTE) NETS for Teachers Project, a US Department of Education, Preparing Tomorrow's Teachers to Use Technology grant facilitated a series of activities and events resulting in a national consensus on what teachers should know about and be able to do with technology. The project will also provide models for teacher preparation programs to use in incorporating technology in the teacher preparation process and disseminate these promising practices for preparing tomorrow's teachers to use technology effectively for improving learning.

The Challenge 2000 Multimedia Project
Project-Based Learning
with
Multimedia

Challenge 2000 Multimedia Project

Exhibitor: Michael Simkins

The Challenge 2000 Multimedia Project is an innovative program that harnesses the power of multimedia to engage students in challenging learning activities. Students create sophisticated multimedia presentations drawing on real-world information and research methods that teach technological skills and foster valuable workplace competencies such as teamwork, communication, planning and problem solving. Students display their work at Project-sponsored multimedia fairs. The Multimedia Project is both a curriculum development and professional development project. Teachers establish a peer "learning community" in which they gradually take on responsibility for planning and conducting their own professional development. The Project provides support in the form of on-site mentors, training workshops, mini-grants for equipment and supplies, increased time for planning, and networking opportunities.

Physics Modeling Workshop for Teacher Enhancement Southern Arizona

The Modeling Instruction in High School Physics Project integrates the computer into the K-12 science curriculum by training and supporting physics teachers as local experts in science teaching with technology. These teachers become Teaching with Technology Resource Agents and subsequently serve their schools and school districts as leaders in incorporating technology into science classrooms and reforming science teaching to meet the National Science Education Standards. In eight weeks of intensive modeling workshops over two summers, teachers engage in a complete revamping of high school physics.

Middle-School Mathematics through Applications Project (MMAp)

Middle school Mathematics through Applications is a multifaceted program to help under-served students learn high-quality mathematics through real world applications and the significant use of appropriate technologies. The three facets of the program include:

- Pathways to Algebra and Geometry - software and curriculum for classroom use.
- WebMath - web-based teacher professional development.
- Primes - multimedia parent outreach.

Pathways to Algebra and Geometry (mmap.wested.org) is a complete two-year middle school mathematics program, published by Voyager Expanded Learning. Pathways prepares our nation's diverse population for the future, exceeds national mathematics standards and uses technology inside a comprehensive middle-school math program. The curriculum materials and software make math relevant, accessible and successful for middle-school students. While working on complex and exciting real-world design problems, students grapple with mathematics from basic skills to higher level concepts. Pathways was originally developed as the MMAP Comprehensive Curriculum at the Institute for Research on Learning and the MMAP/Pathways Implementation

Center is now based at WestEd.

WebMath (mmap.wested.org) is an Internet-based learning environment and community for middle school mathematics teachers. Technology allows teachers to conveniently learn the high-level mathematics critical to teaching Standards-based mathematics, and develop connections between the real world and formal math. Using computers from home or school, teachers participate in weekly online discussions, use interactive applets and submit homework electronically. Teachers move from solving problems based on maps to proving that cross multiplication works. Self-paced versions of the course are available.

Primes (primes.wested.org) involves parents in their children's schools and the mathematics that their children are learning through multimedia workshops and a television special. Reaching out to parents of traditionally underserved students, Primes engages parents in fun projects and topics from daily life?everything from crafts to car-buying to lunches for picky eaters. The underlying message is that school mathematics uses the same thinking skills we use to solve problems in everyday life.

The WEB Project

Exhibitors: Fern Tavalin, David Gibson, and Penny Noolte

The WEB Project (http://www.webproject.org) began as one of the original Technology Innovation Challenge Grant Programs funded by the U.S. Department of Education in the fall of 1995. The Project formed a consortium of community organizations, small businesses, and educational institutions that collaboratively learned how to employ new technologies to effect systemic reform in school systems throughout Vermont. The project utilizes multimedia production and telecommunications as:

- an educational environment for student inquiry and expression
- a medium for presenting and assessing student work
- a virtual faculty room for professional discussions about work

The WEB Project has been designed to service all students and current participation represents a range from urban middle class to rural poor schools. Federal support goes primarily to isolated schools with limited resources.

The Connected Learning Community @ Mott Hall: Bridging the Digital Divide with Anytime Anywhere Learning

Mott Hall, in New York City's Community School District Six, is one of the nation's most challenged schools. The Harlem school has the largest number of bilingual students of any school in New York state and one of the largest in the country. More than 90 percent of the students live in poverty. Teachers, parents and administrators are united in their goal to find ways to make students successful, to acquire the skills they need for professional roles, and to enable them to return to their communities as leaders. Anthony Amato, the district superintendent, was committed to providing his students with access to technology. He knew other children had computers at home and at school; in order for his students to be competitive, they would need to use technology for more than 45 minutes a week in the computer lab. Then Amato discovered Anytime Anywhere Learning, which provides for every student to have his or her own portable computer to use both at home and at school. With strong parent support, the school instituted a portable computer-based program beginning in the fifth grade. Parents and the district share the costs for the portable computers. And now, they share the enthusiasm, too.

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DEPARTMENT OF EDUCATION · UNITED STATES OF AMERICA

The Secretary's Conference on Educational Technology 2000

EVALUATION TOOLS

profiler
online collaboration tool

Profiler inspires cooperation and collaboration among teachers and students to help them improve their skills around a general topic. Use Profiler to strengthen your school district's ability to share expertise. You can take a survey to assess your technology abilities and find someone who can help you strengthen these skills within your school.

Welcome to
enGauge
A Framework for Effective Technology Use in Schools

Developed by NCREL with the Metiri Group, enGauge provides a comprehensive view of critical factors in an educational system that strongly influence the effectiveness of educational technology.Scheduled for piloting in fall 2000, enGauge is a new Web-based framework and tool set designed to help schools and districts use technology effectively for learning, teaching, and managing.

CEO Forum

The STaR Chart identifies and defines four school profiles ranging from the "Early Tech" school with little or no technology to the "Target Tech" school that provides a model for the integration and innovative use of education technology. The STaR Chart is not intended to be a measure of any particular school's technology and readiness, but rather to serve a benchmark against which every school can assess and track its own progress.

SouthEast and Islands Regional Technology in Education Consortium (SEIR*TEC) is a group of national, regional, and university-based organizations, that provide technology-related assistance through awareness, policy development and planning, staff development, and evaluation. SEIR*TEC's mission is to encourage and support placement of technology in all classrooms for all learners across grade levels and to ensure that technology is an effective tool for successful learning. SEIR*TEC serves states, jurisdictions, school districts, preservice training institutions, adult and family literacy programs, and other constituents in Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Puerto Rico, South Carolina, Tennessee, Virginia, the Virgin Islands, and West Virginia.

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DEPARTMENT OF EDUCATION
UNITED STATES OF AMERICA

The Secretary's Conference on Educational Technology 2000

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Expanding International Education through the Internet: No Longer Limited to the Global Studies and Language Curriculum

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Director, I*EARN-USA

The White House has recently drawn attention to the need to expand and enhance international education in the United States. President Clinton has written, "To continue to compete successfully in the global economy and to maintain our role as a world leader, the United States needs to ensure that its citizens develop a broad understanding of the world, in other languages, and knowledge of other cultures. America's leadership also depends on building ties with those who will guide the political, cultural and economic development of their countries in the future."[1]

President Clinton continues, "The Secretaries of State and Education shall strengthen and expand models of international exchange that build lasting cross-national partnerships among educational institutions with common interest and complementary objectives." He also notes that, "The Secretaries of State and Education, in cooperation with other agencies, the academic community and the private sector, shall promote wise use of technology internationally..."

In the 1980s, there was a similar governmental interest in enhancing international awareness and education--through the expansion of citizen exchanges. While significant for the persons involved, the youth and student exchanges that resulted from this important initiative tended to be focused on the individuals who underwent the transformational experiences involved in crossing cultures at an early age and those immediately in contact with them.

It was an important, yet personal experience for a relatively small number of people who physically traveled to different countries.

What sets the new international education initiative apart, is that in 2000, for the first time in human history, the potential exists for exponential growth in direct international interchange. It is an interchange that has the ability to heighten cultural awareness and provide opportunities for direct life applications of the knowledge gained by crossing traditional boundaries of nation, language, time and culture.

Through the Internet, significant opportunity exists for human-to-human interactions, experiential learning and direct curriculum applications. Our students have the opportunity to both learn and teach through direct interaction. Further, students have the opportunity to observe, learn and address the serious global issues for which education is designed to prepare them as adults. Technology now gives students the means to directly interact on these issues. Therefore, the challenge for education is to develop curriculum-based strategies that are relevant to this context. U.S. students can then learn, first hand, the very divergent human socio-economic and political realities that exist in the world and participate in meaningful project-based approaches (service-learning) that produce, meaningful, educational and real-world outcomes.

The Context of International Education

According to a United Nations Development Programme's "Human Development Report," the planet holds 1.3 billion people who live on incomes of less than one dollar a day; at the same time, the three richest nations in the world have assets that exceed the combined gross domestic product of the poorest 48 countries.[2] In this reality, former Costa Rican President Oscar Arias writes that as the material transformation occurs through the world economic order, there must be a parallel expansion of a consciousness that the issues of "environmental destruction and human deprivation, of disease and malnutrition, of conspicuous consumption and military build-up are worldwide problems--problems that affect us all." Arias points to the critical role of education in the fostering of this consciousness.[3]

This economic reality provides both a challenge and opportunity. Teachers throughout the United States are looking to expand interaction with peers around the world. The use of on-line technologies in international education is very recent. During the past 15 years, there has been a general progression in on-line international education, characterized by the following over-simplified steps:

1) In the late 1980s, foreign language teachers (and ESL teachers in other countries) were some of the first to recognize the potential for this technology to bring authentic interaction and materials into their classrooms.

2) In the 1990s, global studies and world affairs teachers learned that they could heighten interest in the issues being discussed if their classes were interacting with real students and teachers in the countries that were in the news or were part of the curriculum.

3) In 2000, international collaborative education is on the threshold of being integrated into **all** aspects of a teacher's curriculum and we are fortunate to have educators who now have 5-10 years of experience to help with professional development

This increase in interest across all subject areas is a result of the general acceptance that U.S. students need to have skills that are applicable to a 21st century global economy. We know that students need cross-cultural awareness and appreciation, flexible and critical thinking skills, communication ability, team work experience, technology skills, and the realization that no nation works in independent isolation, but is interdependent on the actions and perspectives of many others around the world. Further, there is a growing awareness that the widening gap in income, health, access to technology and information around the world is one that must be addressed by all if global political and economic systems are to thrive.

As teachers reach out to link with peers in other countries and as schools in the United States improve their technology base and connectivity, the reality of most of the world's schools and households must be kept in mind. It may seem obvious, but we must constantly remind ourselves that it is the international interaction and education that benefits our students, not the use of high-end technology that our schools may have just acquired. I say this because I am always being asked by U.S. teachers who have installed the latest in video-conferencing technology to match them with schools around the world with which they can use this technology, only to disappoint them with a very small number of possible connections.

In short, the faster schools in the United States attain broadband access and higher-end technology, the fewer international schools we will be able to link with on an equal basis. As U.S. schools acquire this incredible technology, they must realize that:

- most schools in the world do not have computers
- most schools in the world have one telephone line--used solely for administrative purposes
- many of the 5% of schools having Internet access use dial-up connections over slow and expensive telephone lines

This reminder is not presented to dampen enthusiasm among U.S. teachers to link with colleagues around the world, but rather to assist in the process of effective interaction. Indeed, I*EARN teachers in some countries have been engaging in project-based learning since 1988, often with minimal technology and connectivity, yet with demonstrable results. Teachers in the United States simply need to recognize the hurdles which need to be overcome and can be surmounted.

This availability of equipment is changing rapidly as a result of notable private and public sector initiatives on the part of many Ministries of Education and Internet and hardware providers. For example, a number of Ministries of Education have announced policies that will result in computers being placed in all schools in their country within 2-4 years.

But, as we know, the installation of computer equipment and Internet access is only the first (and perhaps easiest) step toward effective integration into the classroom. Teachers need effective professional development and support on an on-going basis. After all, schools in the United States have had computers in their schools for over 20 years now and yet without on-going professional development Internet resources and interaction are not used extensively in collaborative project work in our own country.[4]

Internet as More than a Research Tool

Many educators have written on the research benefits of the Internet in the field of international global studies. It clearly puts into the hands of teachers and students materials and resources that have been out of reach and that are more up-to-date and certainly less expensive than printed materials. This global resource library is without precedence in history. It has the potential for enabling millions of persons in local communities in every part of the world to have access to the same information and resources enjoyed by educators and students in connected schools. This can be of particular importance in communities in which libraries, books and even paper are scarce or seriously out-dated.

More importantly, the Internet also has the incredible potential for creating information and materials from a local perspective in national and local languages--often for the first time--rather than having to rely on resources developed in North America or Europe about the world's cultures.

The educational value of this global research library cannot be underestimated. Of course, this library, like earlier collections of printed resources, also brings with it the need for our students to have critical thinking and analysis skills to evaluate the content of materials.

Yet, to see the Internet solely as a larger, better, more visually-pleasant library, is to miss its most important value--its ability to link humans for international collaborative learning and action. Over the past 12 years, we have seen that it is the **peer interaction** across borders, languages, cultures, and time-zones that stimulates students and teachers to be active participants in the learning process.

The simplicity of this concept belies its importance and potential for revolutionizing education. We are leaving a very long era of learning about cultures from a distance and entering an age of students learning both by interacting with those cultures and explaining their own.

In this paper, I will outline what I consider to be the most critical impact on international education in the United States, and, more importantly, what must be in place in local schools if students and the nation are to effectively attain these benefits.

First, I would like to list a number of assumptions that I make in discussing, indeed, advocating for the integration of on-line technologies to enhance international education.

Assumptions

Assumption One: There is value to the teacher who is responsible for delivering (or facilitating) a quality education to American students. It is my experience over the past ten years that on-line international interaction using technology:

1) Provides a new sense of community by encouraging and furthering connections both within local schools, as well as far beyond school school walls
2) Enables a teacher to acquire new teaching/facilitating/learning techniques and skills
3) Positions a teacher to become a cross-cultural asset/resource for the school and community
4) Motivates teachers by observing higher motivation and academic achievement among students

A 1996 Australian assessment by the Whalesong Foundation for the Ministry of Education of Victoria of the "Global Classroom" project through which classrooms engaged in international collaborative project work, found dramatically positive rates of teacher satisfaction with teaching and learning enhancements.[5]

An English teacher in Latvia who worked for a school term in 1999 in an interactive Learning Circle with schools in the United States, Kazakhstan, Italy and Germany, describes at length the new skills she observed her students gaining, and then points out:

> ***I must say that the project enriched not only the students, but also me, their teacher. It gave me an opportunity to work creatively, to widen my knowledge of computers, not only to teach students, but also to cooperate with them, and to build friendships that continue so far.***[6]

Assumption Two: There is value to the student in terms of learning outcomes and positive attitude change.

1) Teachers provide real classroom testimonies on a frequent and consistent basis that students are more motivated to learn as a result of engaging in on-line collaborative work with peers internationally. For example, one teacher at Erasmus Hall High School in Brooklyn, New York, observed his students scoring higher on state Regents exams and noted, "The greatest benefit of these on-line projects is that they teach students to think critically and explain themselves thoroughly." [7]
2) Teachers and students both report that on-line collaborative work gives practical applications for language and global issues courses. Research by language teachers, for example, indicates that enrollments in language courses rose--even in languages other than the one involved in the international interaction--because students newly perceived a reason for their study.

3) As the economic and political systems become more closely integrated worldwide, U.S. students need to be prepared for a new century in which worldwide interaction will be a daily occurrence. On-line collaboration provides a safe and educationally sound environment for cultural exploration, while developing a comfort with working with a widely-diverse community.

Assumption Three: In an increasingly interdependent global society, there is value to this country to have U.S. students receive an education that values cultural differences and global exploration. As early as February 1966, President Lyndon Johnson addressed the issue of international education:

> ***"Schooled in the grief of war, we know certain truths are self-evident in every nation on this earth:***
> - ***Ideas, not armaments, will shape our lasting prospects for peace***
> - ***The conduct of our foreign policy will advance no faster than the curriculum of our classrooms***

> ***- The knowledge of our citizens is one treasure which grows only when it is shared***
>
> ***International education cannot be the work of one country. It is the responsibility and promise of all nations. It calls for free exchange and full collaboration. We expect to receive as much as we give, to learn as well as to teach."***[8]

Heightened international education and interaction is seen to benefit the United States (indeed, any country) in three ways:

1) Its citizens are more prepared and skilled to enter into global political, financial, and cultural interchanges. The classic example of that need was when General Motors introduced the "Nova" car in Latin America and discovered afterwards that Spanish speakers did not want to buy a car whose name means "doesn't go."
2) Its citizens can respond to domestic and international civic responsibilities with more knowledge and cultural sensitivity and therefore, with more effectiveness
3) Likewise, citizens in other countries also get to know the people and culture of the United States.

Benefits of Internationalization of Education through On-line Collaborative Project Work

There are obvious benefits from international on-line networking to language and world cultures classes. There is in fact, a growing body of literature on the use of e-mail and other Internet interactions to enhance second and third language abilities.[9] Two pioneer language teachers, one in Rochester, NY and one in Moscow, using telecommunications as a part of their classroom activities, have seen that it can be a rich source of authentic teaching/learning material. They saw improvements in language skills acquisition when the following four elements were integrated into the language curriculum:

1. ***Teacher-made material based on telecommunications exchange***
2. ***Creative writing exchange***
3. ***"Live" material related to project work***
4. ***Material prepared by students in one country to foster the study of foreign language in the other country.***[10]

My own organization, I*EARN-USA, has recently partnered with the Office of Citizen Exchanges of the United States Department of State to demonstrate that English language skills are enhanced when students in eleven pilot countries engage in on-line collaborative projects with native speakers.

Similarly, teachers who are focusing on a country, region or culture as part of a global studies course are quick to realize the potential for developing links with peers and classes in regions under study. Authentic interaction gives a sense of realism and relevance to a culture that is often initially viewed as distant, peripheral and esoteric.

Typical of this experience is a teacher in Ukraine who participated in the I*EARN "Kindred Project," in which students describe their family structures, patterns and traditions from their cultural perspective:

> ***We are so excited working in the project because we ourselves learned so much about our students, as if the project touched the hidden strings of their souls which turned out to be so kind and interested.***

Heightened student motivation to explore and learn on a self-directed basis is a common theme of teachers utilizing telecommunications in foreign language and global studies classes. Teachers report that students go beyond the teacher's lesson plan and assume responsibility for learning and then sharing that learning with other students in the class.

Beyond these benefits of international networking to language and cross-cultural classes, it is becoming clear that significant benefits also can be gained by integration of international telecommunications into other (perhaps all) components of the curriculum.

Internet-based global collaborations benefit math, science, art, health and other classes

What was seen in initial language and global studies classes is now visible in science, art, literature, health, math and other classes. On-line collaborative project work heightens student interest in these subjects as well. Applications in these subject areas also results in a recognition that, regardless of the aspect of life, everything we do has an international connection--helping to build that "consciousness" about which Oscar Arias wrote.

Listening to teachers and observing the work of students, the benefits of internationalizing the curriculum through the Internet fall within the three following categories:

1. Skills Development
2. Motivation
3. Opportunities for action from the learning

1. Skills Development

A body of evidence is now available to suggest that significant skills development results from on-line international interaction, including enhanced reading, writing, presentation skills, geographic knowledge, and self-confidence.

One teacher in Arizona writes that her bilingual students gained important communications skills and a sense of pride when they worked with students in Romania--a country with a Romance language with ties to Spanish:

> ***Students have become more aware of their work and presentation skills. Last year my students were involved in a project that connected Math across the curriculum and the Globe. Most of my students do not have a computer in their home and were unaware of of the world outside of theirs. They gain an understanding and awareness of the importance of making oneself understood when they received an email from fellow keypals in Romania (a place they had to look up and wanted to know a bit more about) asking them to reexplain their directions and make them clearer and more concise. My bilingual students wrote some of their work in Spanish, also. They felt that their other language abilities were being appreciated especially on the "outside". They were extremely proud of their work.*** <http://equity4.clmer.csulb.edu/netshare/gdeklerk/gln/>[11]

An ESL teacher in Hawaii points out that her students, recent immigrants from Pacific Islands, gained technical skills as an integral part of their international interaction with students in their birth nations:

> ***Take a look at <http://www.konawaena.k12.hi.us/boisvert/ctc/handwelcome.html>. If you click on any of the students' Power Point presentations, you will see that our Marshallese and other ESL students have been using technology to link their old world with the new one, which is the USA. If I had more time, I could talk to you at length about the benefits of technology for our ESL students. They are chatting in their respective ethnic groups' chatting rooms, and often times in each other's so are using English to communicate across oceans and continents. It helps them to feel connected. They love it!***[11]

Geography becomes real in international on-line work and percolates through math and literature classes, as well as in hallway conversations. A teacher in North Carolina writes:

> ***When we started, most of the students had no idea where Bulgaria was located, much less any idea as to its history. In the course of our participation, the students learned some basic facts about the country, had a speaker from Bulgaria to visit the class, learned about some Christmas in Bulgaria and about martinitsas, and came to feel a sort of personal connection to the Kosovo situation that was a different perspective from most of their friends. In summary, a place on the map became real to the students and it will forever be that way to them.***

Self-expression skills often emerge that were unintended, For example, another teacher in North Carolina notes:

> ***I have seen this partnership turn many of my students from being self centered to a more balanced student. It has also allowed my students who are less vocal and social, to participate in a project that allowed them to be themselves in a non-threatening way. They were able to communicate and express ideas without fear.***

Similarly, involvement by female students has been found by I*EARN and the WorLD Program (World Links for Development) to be significantly higher in on-line project-based learning than male participation. Teachers observed that self-confidence and self-esteem rose among girls after international collaborative project work. It was observed that females had the chance through e-mail and on-line interaction to provide input and contributions because it allowed for interaction in an environment different from the classroom in which they felt intimidated or in competition with male students for teacher attention.

2) Motivation to Learn

Regarding the role that on-line interaction plays to motivate students to learn and explore, a headmaster in Karachi, Pakistan writes:

> ***This mail is meant specially to thank you for all the responses you are posting for our students. You cannot imagine the intensity of the encouragement our students are getting from the responses made to them on top of seeing their work a part of these conferences and read by people all around the world. These days there is a creative writing mania all over the school. Before this it used to be a real effort for our English teachers to motivate students to write on their own and put their feelings as well as real life issues in words. Now it is occurring naturally, all students are indulging in creative writing so much that it is difficult for us to handle but it is amazing I mean the speed with which the love for creative writing is developing. Our teachers are now most optimistic about students literary abilities now.***
>
> ***Giving our students a global exposure and enhancing their communication skills I am again thankful to you for taking time out for responding to our students. Your few words make a world of difference to their academic life and interest in the subject.***

The interaction also enables students to see their own lives in a larger and comparative milieu. For example, through a global arts and culture project that links indigenous/native youth in ten countries, a teacher in Mississippi notes:

> ***The students of Choctaw Tribal Schools (as with other First Peoples participants) have discovered a sincere sense of community with indigenous students they have not nor probably will never meet. They have shared their pride and mis-fortune, collaborated for***

> ***improvement and reveled in cultural celebration.***

Interaction with real students in different cultural settings sparks a curiosity that does not stop at the boundaries of a 45 minute period. It creates, as noted by this North Carolina teacher participating in the ISPT (International School Partnerships through Technology) Program (http://www.ga.unc.edu/NCCIU/ispt/), a "flame" of interest and a love of teaching and learning:

> ***I just bubble with excitement for this project and the future of this project. I do not want to contain my enthusiasm. I am probably like the proud parents or grandparents that say, "Let me show you a picture of__" instead I say, "Let me show you this email or this project or tell you this story." My students come to class and say, "Are we going to work on the project today? Did we get any mail?, What do you think is going on there?, Did you see___ and ___ about their area on the news?, When are you going to show us how to do ____ and ____ so we can do that with our partners?, Why did you say they aren't able to write right now?" These daily questions reaffirm what I feel. They keep the fire burning and I do not want it to go out for them, for future students, or for myself. This project has been a wonderful way to make my curriculum more relevant, to teach cultural diversity, to teach appropriate social skills, workplace readiness (the fact that they may be working with someone from a different culture or race), and that living in a remote area doesn't mean that you are cut off from the world and that world's events.***

These anecdotal examples were also reflected in the results of a 1992 assessment of the pioneering "New York State/Moscow Schools Telecommunications Project." This assessment noted a dramatic increase among U.S. students in interest in international affairs, reading news magazines at home and discussing social and/or political issues as a result of their on-line project work with students in Russia.[12]

3) Connecting Learning to Action

The Internet is a powerful tool for connecting learning to action as students collaborate on real issues facing young people in the world today. Internet-based international education can help foster what Oscar Arias referred to as the "parallel expansion of a consciousness that the issues of "environmental destruction and human deprivation, of disease and malnutrition, of conspicuous consumption and military build-up are worldwide problems--problems that affect us all."

Further, the Internet can provide specific ways in which students can apply the learning and consciousness to address the issues about which they have studied. For example, a teacher in Winston-Salem, North Carolina describes what happened in her class:

> ***The 9th and 10th grade students in Candi Lavender's social studies classes were involved with an International School Partnership with a school in Moldova. As part of the partnership a website was created and each side contributed pictures, introductions, and news items. Through this correspondence the U.S. students learned of the desperate situation of orphans in this former Soviet Union country. They asked permission to collect donations to send to Moldova. With guidance from Mrs. Lavender, the students organized and carried out the collection, which totaled $500.00. The check was sent to a U.S. military liaison officer stationed in the Capitol city and arrangements were made for one orphanage to receive fresh milk deliveries for an entire year! Mrs. Lavender's students not only gained heightened awareness of events in Moldova, but also initiated an appropriate response to a specific situation that they felt deeply about. These students became aware of how the actions of one school community could positively impact another community an ocean away. There was an incredible sense of pride and accomplishment on the part of these adolescents.***

A technology coordinator in Albuquerque, New Mexico writes:

> ***Children in Carolyn Meehan's 3rd Grade Class at Sandia Base Elementary***

(SBE) in Albuquerque, NM, participated in the "No Child Without a Smile" Project. The children's teacher learned about the project through her work in I*EARN. The purpose of the project was threefold: to raise funds to support education and medical efforts in Bosnian Refugee camps; to reach out to the children in the camps with personal, caring messages from children around the world; and to engage children in learning about Bosnia in the context of classic elementary school curriculum. The children at SBE made greeting cards and sold them to parents, neighbors, visitors, and themselves for $1.00. The buyers wrote notes to the Bosnian children and the children mailed the cards and the money to the Project Coordinator, Narcis Vives in Barcelona, Spain. The SBE children did this work as part of their regular curriculum: the counting of the money, keeping track of how much they took in, was part of arithmetic, for example. They made graphs showing how much they got on what days. They wrote about their experience as well as writing messages. Elementary children are still learning fine motor skills and the cards were drawn very precisely with rulers. Finally, the children knew exactly where Bosnia was on their globe. They learned about the terrible conflict there. These children have had a real experience with global citizenship. They have made a difference in other children's lives. It isn't necessary to approach global education as a separate enrichment activity. With a bit of imagination, it can become integrated into ongoing curriculum goals.

One teacher, Kristi Rennebohm Franz, Pullman, Washington, was recently featured on the PBS series on the Digital Divide. Ms. Rennebohm Franz has successfully integrated international networking projects into all aspects of her rural classroom and curriculum. Through her research and many years teaching experience, she has developed the "WRITE to Care Program" (WRITE = Writing and Reading though Integration of Technology in Education). This program is based on the premise that students care about their learning (and thus learn better) when they engage in interactive collaborative on-line projects that focus on caring. Her curriculum, which includes examples of how international project work fits all subjects, is now on the WWW: <http://www.psd267.wednet.edu/~kfranz/>. Kristi's students have learned to read and write better through interactive international on-line project work in I*EARN.

Challenges to Attaining These Benefits

The benefits of international collaboration clearly are attainable. But in the process, school administrators and teachers face a number of challenges that must be addressed. Many of these challenges are familiar to educators involved in national on-line work. The challenges include:

1. Equipment.
    a. On-line technology must be accessible and convenient to every teacher—located as close as possible so it can be used at appropriate moments in a history, literature, art or biology class.

    b. The great chasm of technology and Internet connectivity between schools in the United States and international schools needs to be addressed. While U.S. schools increasingly have high-speed bandwidth and video conferencing capability, in most countries, e-mail is the maximum level of technology available and the gap is widening.

    The opportunity is to empower students to play a role in bridging the gap through such citizen-to-citizen projects as the "First Byte Project" in South Africa <http://wcape.school.za/pfb/pfb.htm>.

    Two new initiatives seek to address this serious obstacle: Alliance for Global Learning http://www.global-learning.organd the GEMS project between Schools Online http://www.schoolsonline.org> and iEARN <http://www.iearn.org>.

2. Assessment
   a. Anecdotal evidence demonstrating the value of international interaction and collaboration needs to be reinforced with more studies on the academic impact on student performance. At a time when teacher accountability is based increasingly on exam scores and the ability to meet state standards, there are only a few examples of how state curriculum standards are addressed by international collaboration.

3. Training
   a. Attention must be focused on coaching educators how to teach collaboratively. This style of teaching, a key element of on-line, project-based learning, is new to many educators—both in the United States and around the world. Most educators have no experience working with the teacher down the hallway, much less with teachers in different time zones, across borders, speaking different languages, working in different educational systems and approaching life from very different cultural perspectives.

   b. Many educators and their pupils worldwide will need to learn to feel confident in a classroom in which students assume some independent responsibility for their own learning through interactive discussions and cross-cultural exploration.

4. The Tower of Babel
   a. Teachers wanting to work with many of the world's countries will need to be able to accommodate languages other than English. Teachers wanting their second grade students to engage in project work with peers in Latin America, for example, are sometimes surprised when I ask if their students speak Spanish.

   In these cases, it can work to partner these primary school classes with a local high-school Spanish language class, which uses the project work messages as their "authentic texts" to translate. There are some wonderful examples of recent immigrant students serving in this role – enabling them to become assets in a local school and community rather than a perceived liability.Still other teachers are experimenting with software and Internet sites that provide machine-generated translations.

5. Cross-Cultural Complexities
   a. School terms and schedules are very different around the world, particularly when teachers in northern and southern hemisphere schools want to work collaboratively. In Argentina, for example, the school year runs March to mid-December. After allowing for preparation time and year-end exams and proms, teachers wishing to work with Argentine schools have only the period April-May and October-November to engage in interactive work.

   b. Cross-cultural interaction often takes place primarily in a medium that is mostly text, leaving ample room for misunderstandings when facial expressions, emotions and ability to immediately ask for clarification often are not possible. Successful teachers use combinations of written materials and visual aids (often sent by "snail mail"), and when possible, CU-See Me or NetMeeting video conferences. These live, visual interactions can be done with normal modems.

   c. Teachers sometimes feel that unless they teach world history, social studies or a foreign language that they lack the expertise to integrate international education into their classes. One teacher in Wisconsin related the following experience in this regard:

   > ***The earth didn't suddenly become round and rotate around the sun because of Copernicus, it just became simpler to describe. Freed of the complicated calculations needed to figure the epicycles of Ptolemy, Renaissance***

> ***astronomers were able to see a new world and a new sky.***
>
> ***Something similar happens today in our classrooms. Letting the whole world into our curriculum makes it easier to teach and learn. Freed of the constraints that made us believe we don't have time for international education, we find global issues and perspectives already thriving in the world of our children—and in our instruction.***[13]

6. Learning must be reciprocal and recognized as such.
    a. Because of the predominance of U.S. media and culture around the world, students in the United States will find that they have much to learn about their peers' countries before they can match their peers' awareness about our culture. It is critical for U.S. students and teachers to explore international interaction with curious and open minds.

What Needs to Happen?

The timing of the renewed focus on international education is fortuitous. The educational technology stage has been set and many teachers are eager to utilize the Internet's potential to bring the world into their classrooms. What is now needed are:

1) A demonstration program in each state or region to create professional development models, building on the expertise, methodology and materials that have been produced over the past decade by educators who have pioneered this work. In many cases, this will require the development of effective team-teaching methodologies among language, global studies and other subject area teachers. Examples of such teams exist for both elementary and secondary schools which can be offered to teachers to adapt and further develop for application and replication nationwide.

2) A compendium of "best practices" in learning through on-line international collaboration for wide dissemination via the WWW.

3) Comprehensive research to assess the learning impact of the interactive use of the Internet in international exchanges, including an analysis of how international collaborative project work addresses specific national and state educational standards. We need to learn from those who have blazed the path.

With the power of the Internet in the hands of teachers and students, we have the potential for realizing the dreams of two Presidents of the Americas, Lyndon Johnson and Oscar Arias. Not only will the conduct of our foreign policy be furthered as international education permeates classrooms, it will be based on the consciousness that the issues of "environmental destruction and human deprivation, of disease and malnutrition, of conspicuous consumption and military build-up are worldwide problems--problems that affect us all."

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Assessing the Role of Educational Technology in the Teaching and Learning Process: A Learner-Centered Perspective

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For over two decades, educational technology has been used to varying degrees in our nation's schools. Numerous studies exist demonstrating that (a) educational technology appropriately applied can enhance learning and achievement compared to traditional teaching methods and (b) the benefits of educational technology cannot be adequately separated from other variables that impact learning in the larger instructional context. In spite of these findings, however, many school systems are being asked to justify the use of computer-based technologies to enhance learning in school settings (cf. McMillan-Culp, Hawkins, & Honey, 1999; McNabb, Hawkes, & Rouk, 1999). Much of the pressure to assess the benefits or "value added" by technology are the costs associated with this medium and the concern about whether teachers are being adequately trained to use technology effectively.

I would like to argue that it is time to think differently about assessing the role of educational technology in the teaching and learning process. Let me explain by addressing four fundamental questions: (1) What is learning? (2) What is the purpose of education? (3) What knowledge base is needed to apply educational technology appropriately to the teaching-learning process? and (4) What are implications of the learner-centered framework for the application and assessment of educational technology?

What is Learning?

The past century of research on learning has been a journey through a variety of theories and research that have alternately focused on behavioral, emotional, and/or cognitive aspects of learning. As we enter this new millennium, there is an increased tendency to look at learning from a more integrative and holistic perspective. Part of this impetus has been the growing recognition from various research perspectives (e.g., neurological brain research, psychological and sociological research, biological sciences research) that meaningful and sustained learning is a whole person phenomena. Learning can be reduced to a purely physiological or behavioral process, but in so doing, we reduce human phenomena to the level of lower order animals. In fact, we now know from brain research that even young children have the capacity for complex thinking (e.g., Caine & Caine, 1997; Diamond & Hopson, 1998; Jensen, 1998; Sylwester, 1995; Wolfe & Sorgen, 1990).

From my research and that of others who have explored differences in what learning looks like in and outside of school settings, several things become obvious (e.g., Kanfer & McCombs, 2000; McCombs, in press; Zimmerman & Schunk, in press). Real life learning is often characterized as playful, recursive and non-linear, engaging, self-directed, and meaningful from the learner's perspective. Motivation and learning look like the natural processes they are in real life learning - but they rarely seem so in most school settings. Why? Zimmerman (1994), for example, has argued that self-regulated learning is, by definition, only possible in contexts that provide for choice and control. If students do not have options to choose among or if they are not allowed to control critical dimensions of their learning (such as what topics to pursue, how and when to study, and the outcomes they want to achieve), regulation of thinking and learning processes by the self is not fully possible. Externally imposed conditions then regulate the content, structure, and process of learning.

The important point is that in too many school experiences, the learning process is rote, surface, and/or low level. Many students are complying with mandated learning demands to master a growing number of standards and benchmarks - they are going through the motions but becoming increasingly alienated and frustrated in the process. Too many students complain that school is boring, that what they are learning is irrelevant, and that teachers don't care or seem angry and stressed out (McCombs & Whisler, 1997). Is this what we want or what we intend as the purpose of education?

What is the Purpose of Education?

Within a person-centered view (e.g., Combs, 1962, 1986), schools are concerned with creating the kinds of experiences that will produce productive, healthy people. Consistent with this view, Fullan (2000) has argued that the purpose of education is to build learning communities - communities that bring moral purpose back into teaching and reconnect teachers with their fundamental purpose as making a difference in young people's lives and changing the quality of relationships throughout the system. For Thornburg (1999), the purpose of education is shifting due to the exponential growth in access to information in the past 50 years. He believes that education now needs to foster lifelong learners, to transform the value we place on what we already know, and to create new networks for dialog, reflection, and contextual applications of learning in the real world.

In this context, we need educational models that reconnect learners with others and with learning - models that are person-centered while also addressing needs for challenging learning experiences. Learning experiences in school should prepare learners to be knowledge producers, knowledge users, and socially responsible citizens. Of course, we want students to learn socially valued knowledge and skills, but is that sufficient? Again, as Thornburg (1999) has argued, we must move beyond the past where information was seen as a scarce resource and education was a system for imparting information to benefit learners. Now content is abundant and not a good foundation for basing an educational system; rather, context and meaning are the scare commodities today. The new purpose of education is that of helping learners communicate with others, find relevant and accurate information for the task at hand, and be co-learners with teachers in diverse settings that go beyond school walls.

To move toward this vision will require new concepts defining the learning process and the evolving purpose of education. It will also require rethinking current directions and practices. For example, we need to examine current reform efforts that center on the standards movement, which identifies important content and skills. While maintaining high standards of learning, we must not neglect the learning environment and the learning process. The focus must be expanded to include the goals of knowledge conservation, and move toward those focusing on knowledge creation and production (Carroll, 2000; Hannafin, 1999).

From a person- or learner-centered view, the current focus on content must be balanced with a focus on individual learners and their learning needs in an increasingly complex and fast changing world. This balance is essential if we are to adequately prepare students for productive and healthy futures. It is also an appropriate response to students' reports that school is irrelevant, that they feel disconnected from their teachers and peers, or that they just don't want to be in school when they can be learning outside of school - from real life experiences or from technologies such as the Internet. To guide the process of transforming education and to inform educators on how best to apply educational technology in the teaching and learning process, however, a knowledge base is needed. This knowledge base should be one built upon research-validated principles of learning and change in complex human living systems such as education.

What Knowledge Base is Needed to Apply Educational Technology Appropriately to the Teaching and Learning Process?

Research confirms that a focus on personal and motivational outcomes balanced with a focus on high achievement and challenging standards is vital in today's schools if we are to address current concerns about increasing student achievement and preparing students for the future. It is also essential in reducing negative trends such as school dropout, peer bullying, and violence. There is growing recognition that schooling must prepare children to behave in moral and ethical ways. For example, many educators are calling for caring, democratic schooling and instructional methods that build on each student's backgrounds, experiences of reality, and perspectives (e.g., Bartolome, 1994; McWhorter, Jarrard, Rhoades, & Wiltcher, 1996; Noddings, 1995; Ruddick, Day, & Wallace, 1997) - practices that address the personal domain of educational systems.

For practices such as these to become realities, however, we need research-validated principles to guide the design, including the design of effective uses of educational technology to support learners and enhance learning. When the knowledge base on principles of learners and learning is understood, it becomes clear that there must be a focus on human needs and teacher/student relationships. Students must be seen as knowledge generators and active participants in their own learning. When power is shared by students and teachers, teaching technologies are a means to an end rather than an end in themselves.

The Learner-Centered Principles as a Framework

Education is one of many complex living systems that function to support particular human needs (cf. Wheatley, 1999). Such systems are by their nature unpredictable but can be understood in terms of principles that define human needs, cognitive and motivational processes, development and individual differences. The research-validated Learner Centered Psychological Principles (APA, 1993, 1997) provide a knowledge base for understanding learning and motivation as natural processes that occur when the conditions and context of learning are supportive of individual learner needs, capacities, experiences, and interests. Attention to this knowledge base about learners and learning is central to defining the personal domain of educational systems. This domain focuses on the human processes and on personal and interpersonal relationships, beliefs, and perceptions that are affected by and/or supported by the educational system as a whole. The foundation of the research-validated learner-centered principles is essential to designing technology-supported practices that attend holistically and systemically to the needs of all learners.

The Learner-Centered Psychological Principles

Beginning in 1990, the American Psychological Association (APA) appointed a special Task Force on Psychology in Education, one of whose purposes was to integrate research and theory from psychology and education in order to surface general principles that have stood the test of time and can provide a framework for school redesign and reform. The result was a document that originally specified twelve fundamental principles about learners and learning that, taken together, provide an integrated perspective on factors influencing learning for all learners (APA, 1993). This document was revised in 1997 (APA, 1997) and now includes 14 principles that are essentially the same as the original 12 principles with the exception that attention is now given to principles dealing with diversity and standards. [Note to readers: For those interested in research support for the Principles, several sources are relevant. The specific research and theory that was reviewed in developing the Principles is described in McCombs and Whisler (1997). Further research support is also provided in Alexander and Murphy (1998) and Lambert and McCombs (1998)].

The 14 learner-centered principles are categorized into four domains as shown in Table 1. These categories group the principles into research-validated domains important to learning: metacognitive and cognitive factors, affective and motivational factors, developmental and social factors, and individual difference factors. An understanding of these domains and the principles within them establishes a framework for designing learner-centered practices at all levels of schooling. It also helps define what "learner-centered" means from a research-validated perspective.

Defining "Learner-Centered"

From an integrated and holistic look at the Principles, the following definition emerges:

"Learner centered" is the perspective that couples a focus on individual learners - their heredity, experiences, perspectives, backgrounds, talents, interests, capacities, and needs - with a focus on leaning - the best available knowledge about learning and how it occurs and about teaching practices that are most effective in promoting the highest levels of motivation, learning, and achievement for all learners. This dual focus then informs and drives educational decision making. Learner-centered is a reflection in practice of the Learner-Centered Psychological Principles - in the programs, practices, policies, and people that support learning for all.

This definition of learner-centered is thus based on an understanding of the Learner-Centered Psychological Principles as a representation of the current knowledge base on learners and learning. The Principles apply to all learners, in and outside of school, young

Table 1: The Learner-Centered Psychological Principles

COGNITIVE AND METACOGNITIVE FACTORS

Principle 1: Nature of the learning process.
The learning of complex subject matter is most effective when it is an intentional process of constructing meaning from information and experience.

Principle 2: Goals of the learning process.
The successful learner, over time and with support and instructional guidance, can create meaningful, coherent representations of knowledge.

Principle 3: Construction of knowledge.
The successful learner can link new information with existing knowledge in meaningful ways.

Principle 4: Strategic thinking
The successful learner can create and use a repertoire of thinking and reasoning strategies to achieve complex learning goals.

Principle 5: Thinking about thinking
Higher order strategies for selecting and monitoring mental operations facilitate creative and critical thinking.

Principle 6: Context of learning
Learning is influenced by environmental factors, including culture, technology, and instructional practices.

MOTIVATIONAL AND AFFECTIVE FACTORS

Principle 7: Motivational and emotional influences on learning
What and how much is learned is influenced by the learner's motivation. Motivation to learn, in turn, is influenced by the individual's emotional states, beliefs, interests and goals, and habits of thinking.

Principle 8: Intrinsic motivation to learn
The learner's creativity, higher order thinking, and natural curiosity all contribute to motivation to learn. Intrinsic motivation is stimulated by tasks of optimal novelty and difficulty, relevant to personal interests, and providing for personal choice and control.

Principle 9: Effects of motivation on effort
Acquisition of complex knowledge and skills requires extended learner effort and guided practice. Without learners' motivation to learn, the willingness to exert this effort is unlikely without coercion.

DEVELOPMENTAL AND SOCIAL FACTORS

Principle 10: Developmental influence on learning
As individuals develop, they encounter different opportunities and experience different constraints for learning. Learning is most effective when differential development within and across physical, intellectual, emotional, and social domains is taken into account.

Principle 11: Social influences on learning
Learning is influenced by social interactions, interpersonal relations, and communication with others.

INDIVIDUAL DIFFERENCES FACTORS

Principle 12: Individual differences in learning
Learners have different strategies, approaches, and capabilities for learning that are a function of prior experience and heredity.

Principle 13: Learning and diversity
Learning is most effective when differences in learners' linguistic, cultural, and social backgrounds are taken into account.

Principle 14: Standards and assessment
Setting appropriately high and challenging standards and assessing the learner and learning progress-including diagnostic, process, and outcome assessment-are integral parts of the learning process.

Summarized from the APA Work Group of the Board of Educational Affairs (1997, November). Learner-centered psychological principles: Guidelines for school reform and redesign. Washington, DC: American Psychological Association.

and old. Learner-centered is also related to the beliefs, characteristics, dispositions, and practices of teachers -

practices primarily created by the teacher. When teachers and their practices function from an understanding of the knowledge base delineated in the Principles, they (a) include learners in decisions about how and what they learn and how that learning is assessed; (b) value each learner's unique perspectives; (c) respect and accommodate individual differences in learners' backgrounds, interests, abilities, and experiences; and (d) treat learners as co-creators and partners in the teaching and learning process.

Others who have used the term "learner-centered" (e.g., Darling-Hammond, 1996; Sparks & Hirsh, 1997) refer to learning new beliefs and new visions of practice that are responsive to and respectful of the diverse needs of students and teachers as learners. This means that all learning, including that for students and teachers, must include strategies that support diverse learner needs and perspectives, provide time for critical reflection, and opportunities for teachers to co-create practices with their students that enhance learning, motivation and achievement. For Sparks and Hirsh and others, this view of "learner-centered" is a research-validated paradigm shift that transforms education - including how best to use technology to support the new vision.

Of significance in my own work with learner-centered practices and self-assessment tools based on the Principles for teachers and students in K-12 and college classrooms is the finding that what defines "learner-centeredness" is not solely a function of particular instructional practices or programs (McCombs & Lauer, 1997; McCombs & Whisler, 1997). Rather, it is a complex interaction of qualities of the teacher in combination with characteristics of instructional practices - as perceived by individual learners. That is, "learner-centeredness" is in "the eye of the beholder" and varies as a function of learner perceptions which, in turn, are the result of each learner's prior experiences, self-beliefs, and attitudes about schools and learning as well as their current interests, values, and goals. Thus applications and assessments of educational technology must consider student perceptions that their personal and interpersonal needs are being met.

When learner-centered is defined from a research perspective that includes the knowledge base on both learning and learners, it clarifies what is needed to create positive learning contexts and communities. When this occurs at the classroom and school levels, it increases the likelihood of success for more students and their teachers. In addition, a research-validated foundation that focuses on both learners and learning can lead to increased clarity about the requisite dispositions and characteristics of school personnel who are in service to learners and learning - particularly teachers. One implication is that the learner-centered principles can become a framework for determining how to use and assess the efficacy of technology in providing qualities and characteristics of the most effective teachers.

Using Technology to Provide Qualities of Learner-Centered Teachers

In addition to having certain beliefs about learners and learning, research shows that learner-centered teachers tend to have some general characteristics and dispositions in common. At this year's Association for Educational Communications and Technology (AECT) conference, Fullan (2000) stressed that the more powerful technology becomes, the more indispensable good teachers are. In Fullan's view, teachers are needed who are "pedagogical design experts" and facilitators of learning (Brown, 2000; Ellsworth, 2000). Technology may change some of the traditional teacher roles, but it will also require them to engage in more powerful roles - roles that include not only using technology appropriately such that it opens new pathways to learning not previously available, but also require teachers to find ways to build in meaning, purpose, connections, and relationships to the larger world and community outside the school building.

A helpful guideline is McKeachie's (1995) description of the characteristics of great or "learner-centered" teachers, including: presenting material in interesting ways, stimulating intellectual curiosity, giving clear explanations and quality feedback, being fair and skillful in observing student reactions, being helpful and friendly, and providing clear structure and organization to the materials presented. Nolen (1994) reports that another characteristic shared by learner-centered teachers is their willingness to listen to students and acknowledge their voice. By listening to students it is possible to (a) transform schools to better educate students, (b) understand the sense students are making of the curriculum so as to decide how to change it, (c) understand diverse perspectives that need to be part of the theories of learning and teaching, and (d) demonstrate respect for students. Too often attention is given to what we think are the important variables, only to discover they don't make a difference to student motivation, learning, and achievement. These points apply to the changing role of teachers as learners and how technology is used to support learning and social development.

Those working closely with technology and its impact on learning are increasingly recognizing that the search for the impact of technology cannot be separated from the key role of humans in the process. For example, Yakel and Lamerski (2000) studied 15 school sites and found it was the human networks that enabled the successful integration of technology into schools and the surrounding community through key partnerships, community support, and key people. It was people networking that also brought innovations in technology that benefited both the school and the community. And it was key people who led the changes and impacted technology use. Further, Boyle and Rigg (2000) emphasize that human learning must be the focus, based on the assumption that individuals need opportunities for creative problem solving and voice.

What are Implications of the Learner-Centered Framework for the Application and Assessment of Educational Technology?

The implications of the learner-centered framework fall into the following areas: how educational technology is applied to support learners and learning, how technology can be assessed, how learner-centered learning communities can be established, and how we can expand the notion of collaboration and transform the educational system.

Applications of Technology to Support Learners and Learning

As suggested in the learner-centered framework, learners must be supported in their diverse needs and capacities. We know from the research-validated Principles (see Table 1) that there are major categories of factors within all learners that influence learning. When educators and instructional designers understand these factors, the focus is on maximizing natural learning and motivation with instruction that

- is meaningful and relevant from the individual learner's perspective,
- provides appropriate learning challenges and standards,
- accommodates needs to be supported in critical thinking and learning skills,
- attends to the climate and context in which learning occurs,
- honors individual needs for choice and control, that provides for emotional safety,
- supports individual interests and creativity,
- provides positive social interactions and interpersonal relationships, and
- adapts to a variety of individual differences.

In a similar vein but with a focus on learning, Bransford, Brown, and Cocking (1999) suggest that technology can support learning in five ways (p. 195):

- To bring exciting curricula into the classroom that is based on real-world problems and that involves students in finding their own problems, testing ideas, receiving feedback, and working collaboratively with other students or practitioners beyond the school classroom;
- To provide tools and scaffolds that enhance learning, support thinking and problem solving, model activities and guide practice, represent data in different ways, and are part of a coherent and systemic educational approach;
- To give students and teachers more opportunities for feedback, reflection, and revision, including those where students evaluate the quality of their own thinking and products, have opportunities to interact with working scientists, receive feedback from multiple sources which include their peers, and experience cognitive tutors and coaching in areas where improvement is needed;
- To build local and global communities that are inclusive of teachers, administrators, parents, students, practicing scientists, and other interested community people, expanding the learning environment beyond the school walls; and
- To expand opportunities for teacher learning that include helping teachers to think differently about learners and learning, to reduce the barriers between students and teachers as learners, to create new partnerships among students and parents, and to expand communities of learners that support ongoing communication and professional development of teachers.

Beyond these uses, Carroll (2000) has pointed out that highly interactive technologies such as the Internet also make it possible to support both learners and learning in recursive processes of exploration that are non-linear and congruent with natural motivation and learning processes. To support these complex non-linear processes, it is necessary to "think outside the box" of traditional education with its focus on knowledge conservation versus knowledge production. The real assessment issue becomes, as Bransford et al. (1999) and Thornburg (1999) have also recognized, how technology is used and its match or mismatch with what learners need, how they best learn, and the thinking and learning skills that should be supported.

Assessment of Technology in Service to Learners and Learning

There is growing agreement that the key evaluation issue is not technology's value as a tool but rather the effective use of this tool in teaching and learning (Burnham, Miller, & Ray, 2000; Rein, 2000). Further, Bennett et al. (2000) argue that the impact of technology on various aspects of teaching and learning can only be understood in the social context of schools. One of the issues recognized by Bransford et al. (1999) is that there is a need for both small- and large-scale studies that evaluate the goals, assumptions, and uses of technology in classrooms and the match or mismatch of these uses with principles of learning and transfer (p. 240). Thus, their argument - similar to the one I have presented here - is that the focus of technology evaluation be on learning and learners and not the technology per se.

With the learner-centered framework (McCombs, 2000), the focus is on:

- The Learner and each learner's perceptions, needs, and motivation;
- Learning Opportunities and the types of teaching and learning experiences that can meet learner needs for success, belonging, and autonomy;
- Learning Outcomes that include affective, cognitive, social, and performance domains; and
- The Learning Context or climate for learning, including expectations, teacher and technology support, time structures, and adaptability to student needs.

The key issues in using educational technology to support learner-centered principles and practices are:

- Building ways to meet learner needs for interpersonal relationships and connections;
- Finding strategies that acknowledge individual differences and the diversity of learner needs, abilities, and interests;
- Tailoring strategies to differing learner needs for personal control and choice; and
- Assessing the efficacy of technology to meet diverse learner needs.

Thus, I would add that not only do we need to look for the match or mismatch of technology uses with learning principles but also its match or mismatch with learners and their diverse needs. We need a balance of personal and technical supports that are provided with technology. Toward this goal, learner-centered assessment strategies are those that:

- Include the perspective of the learner as the one closest to the learning process and outcomes and whose perspective is the best predictor of learning outcomes;
- Build in ways for learners to co-create assessment experiences, thereby developing personal responsibility for their own learning and learning outcomes;
- Collect self-assessment information that informs instructional design and the selection of technology tools that are used to meet learner and learning needs; and
- Include multiple outcome measures and types of outcome categories that include content and skills as well as affective, motivational, and attitudinal outcomes.

The assessment questions of importance within a learner-centered framework are:

1. How is technology perceived by individual learners and teachers relative to its teaching-learning support?
2. What changes in learning and performance outcomes can be observed with different technology uses and with different learners?

3. What changes in teaching processes can be observed that enhance learning outcomes?
4. What changes in the learning context can be observed that create new partnerships and climates for learning?

The data sources that can answer these questions include:

- Student and teacher self-assessments of technology practices and strategies;
- Student and teacher attitudes toward technology and its specific uses;
- Multiple student motivation measures;
- Multiple student achievement measures; and
- Observational information on learning outcomes, teaching, and learning context.

Beyond these implications of the learner-centered framework, however, there are two other important implications: how this framework can (a) help build schools as learner-centered learning communities and (b) expand the notion of collaboration and transform current educational systems. Technology has an obvious role in both of these areas, but it is a role that must evolve from the foundation of research-validated principles and practices.

Building Learner-Centered Learning Communities

Work by Fullan (1995) on systemic educational reform highlights the importance of creating cultures in which people are free to share basic beliefs and values and struggle with bringing these into agreement in a vision for the school. Weinstein (1998) further argues that to accomplish school level changes, it is necessary to help both teachers and students "change their minds" or modify current thinking. One example of such change in thinking is teachers learning to value student perceptions of practice and using negotiation strategies to work collaboratively with their students to define changes in practice and expectations. When beliefs and thinking change, practices and climate change, and student outcomes shift to more positive expectations, higher motivation, increased learning, and higher achievement. This was recently demonstrated in case studies of participants in five urban middle schools, where Fulton and Torney-Purta (2000) found that it was teacher beliefs about teaching and learning and the learning community that was formed that most led to positive benefits of technology.

When applying technology to building learning communities, another consideration is how to contribute to the spirit of vitality of learner-centered schools. This spirit occurs when the culture is committed to learning and change for all learners, including teachers. Technology can be used to create a culture that supports student motivation, learning, and achievement while also supporting teachers' needs to be learners. That means using technology to create networks among teachers that build on their natural commitment to high achievement for all learners and to ongoing learning, change, and continuous improvement. It is important to note that building a culture of learning and change must be built from within the organization. The process must be one that supports continuous evaluation and improvement of the education process at every level (Joyce & Calhoun, 1995). Critical inquiry into ways of helping students learn better must become a normal activity that involves the whole faculty and builds community. An important outcome of facilitating this kind of change from within, as reported Joyce and Calhoun (1995), is that faculty begin to realize that teaching and learning involves a never-ending process of trying to reach all students in the best ways currently known. The vision must be subject to change, the whole system must maintain flexibility and openness to new learning, transformation, and change.

Somewhat more challenging is the use of technology to develop the kind of learning community described by Caine and Caine (1997): a community with shared values, a common agenda, and collegial connections among teachers and students. In healthy learner-centered learning communities, individuals welcome divergent perspectives because they understand that the underlying outcome is learning and change in a context of respect and caring. The learning community that is healthy works for everyone and encourages rather than eliminates diverse perspectives. When different world views and beliefs are held, inclusive dialogue is the process for learning; relationships become the vehicle for change. As Caine and Caine (1997) acknowledge, learning communities facilitate self-organization as a natural process in adaptive, living systems. They meet individual needs for safety and security, and they encourage new relationships and ways of generating new relationships. In the context of positive relationships and a positive climate for learning, beliefs and assumptions about learning, learners, and teaching can be examined. Active listening, reflection, and critical questioning are tools of the learning dialogue. In addition, Schaps and Lewis (1999) report it is essential to have a dual emphasis on (a) a sense of community and on academic learning and (b) student and teacher thinking and voice in shaping classroom lessons and decisions.

Expanding the Notion of Collaboration and Transforming the Educational System

Providing a context and opportunities for people networking and collaboration is another important feature of learner-centered school cultures that must be addressed in setting up technology-supported learning communities. Fullan (1992-93), for example, highlights the importance of inquiry and collaboration along with technical skills and reflective practices. Collaboration includes sharing, trusting, and support; collaboration is central to daily, joint work and facilitates growth. Working collaboratively, however, often necessitates overcoming problems. These include the problems of overload, isolation, untapped competence and neglected incompetence, narrowness in the teacher's role and administrative resistance to teachers playing leadership roles, poor solutions and failed reform - all of which have a negative impact on morale, motivation, energy, and enthusiasm for change.

Fullan (1997) argues the need for a different premise - one that focuses first on the individual and then moves to the group and organization. Each learner's perspective is a valued and honored medium of learning and a catalyst for learning, change, and improvement in healthy learning communities. These communities must themselves be a model of the processes they want to engender in learners. To produce quality learners, all learners must experience both quality content and processes. As Rudduck, Day, and Wallace (1997) argue, the successful change agenda creates time for dialogue and engages all learners in the process of exploring standards for judging quality. Principles of respect, fairness, autonomy, intellectual challenge, social support, and security guide the standard-setting and implementation process. Time for learning and change are acknowledged and provided for, along with time to share successful practices, experiment, and continually improve.

This takes us to the implications of the learner-centered framework for transforming education and the potential role of technology. Many of those closely associated with the application and assessment of technology in education are recognizing that the current system must be transformed to accommodate the changing needs in our world, our technologies, and what students will need to succeed and help reshape the future. For example, Schank and Jona (1999) see technology as driving educational change by changing the role of teachers, the role for schools, and how curriculum and instruction are developed. Teachers will become co-learners and contributors to the social and interpersonal development of students, counterbalancing the potential of computer technology to lead to personal and social isolation and alienation. Schools will evolve into community centers to further promote student connections to the community around them and to working in groups on real-world projects. The online delivery of education will provide a means to centralize course development and links to academic tutors on a global scale. To support this evolution, Schank and Jona argue that the current focus needs to shift from goal and standard setting to (a) recruiting the best technology experts and designing the best online courses, (b) planning for a vision of school that does not include classrooms, and (c) experimenting with new approaches to schooling that can support anytime, anywhere learning.

Whether technology becomes the primary delivery system for the educational system of the future or whether it is one of the major tools used in the teaching and learning process will require collaborative planning by all constituents involved. This includes students, parents, teachers, administrators, community members, and policymakers at local and national levels. By using the best knowledge available on how people learn, what enhances learning and motivation for diverse learners, and how best to support learning and change in inclusive and respectful dialogue - I have every confidence the best answers will emerge. And from a learner-centered perspective, they won't be the same answers for all learners and all learning communities. With technology, therefore, comes the promise of providing the tools and capacity for networked learning communities that can expand and transform notions of learning and schooling in ways that produce healthy and productive lifelong learners.

The learner-centered framework adds a constant reminder that the human element cannot be left out of even the most advanced technology-supported networked learning communities. Beyond that, it must be recognized that one of the biggest factors to the success of information technologies in learning, following people, is the context of safety and support for learning that is established. As reported by Green and Staley (2000), technologies such as computer conferencing can provide an effective learning tool if they attend to constructing a safe context and interpersonal rapport. And that is our challenge - how to design educational systems where technology is in service to, values, and supports diverse learners and learning contexts. When that goal is embraced, the evaluation question will then be a much different one. I suggest that it will be one centered on understanding how technology can contribute to individual growth and development against personalized learning goals that derive from shared visions for learning in the larger learning community and society. Assessment methodologies will be those that support non-linear learning and match natural learning and motivation processes that occur in life. Rather than assessing the benefits of technology, the focus of technology assessment will be to explore how to enhance those benefits by matching them to learner needs combined with information on how learning best occurs.

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with Nadine Lambert, entitled "How Students Learn: Reforming Schools through Learner-Centered Education", was published by the American Psychological Association in January 1998 and contains a collection of chapters that provide the research base for learner-centered practices at the school and classroom levels. In addition, she helped create a video-supported program. And Learning for All, to inspire a new vision of American education and bring information and useful strategies related to effective learner-centered practice to school administrators, teachers, parents, and school boards. Finally, she has developed a CD-ROM supported education program, entitled The Sun's Joules, for the Department of Energy and National Renewable Energy Laboratory on the topic of renewable energy for middle and high school students. This problem-based, learner-centered, standards-based, and interdisciplinary program includes a Teacher Guide with examples of learning activities and units for teachers to build upon in their own lessons, Facilitator Manual for supporting a two-day workshop on program implementation, and a Standards Reference Document of Colorado and national standards for mapping program content to local standards.

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The Secretary's Conference on Educational Technology 2000

Developing Assessments for Tomorrow's Classrooms

Barbara Means, Bill Penuel, and Edys Quellmalz
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In an inner-city high school physics class in Chicago, students are examining computer images captured by automated telescopes. To identify the types of galaxies represented in these images, pairs of students use software tools to enhance the images on their computer screens so that patterns are easier to detect. They change the colors and brightness of the images, zoom in to look at specific features, and zoom out to get an impression of overall shape; they rotate an image to see it from multiple perspectives. These student activities are part of a technology-supported project called Hands-On Universe. Automated telescopes now capture many more images from outer space than professional astronomers have time to analyze. Developed at UC Berkeley's Lawrence Berkeley Lab with support from TERC, the Hands-On Universe project involves students in reviewing images from space. In the course of these activities, students learn basic concepts and skills of research astronomy and help search for super novas and asteroids. (Two Hands-On Universe student groups have in fact discovered previously unknown super novas and had their work published in scientific journals.) Hands-On Universe enables students to use the same kinds of software tools that scientists use (albeit with more user-friendly interfaces) to examine and classify the downloaded images.

Technology-Supported Activities to Support Meaningful Learning

How People Learn, a recent report from the National Research Council (Bransford, Brown, & Cocking, 1999), applies principles derived from research on human learning to issues of education. The report explores the potential of technology to provide the conditions research indicates are conducive to meaningful learning. The report illustrates how technology can be used to help supply five key conditions for learning:

- real-world contexts for learning
- connections to outside experts
- visualization and analysis tools
- scaffolds for problem solving
- opportunities for feedback, reflection, and revision.

Hands-On Universe exemplifies many of these features, as do other technology-supported interventions such as GLOBE, UC Berkeley's WISE, the Quests from Classroom Connect, Vanderbilt University's Scientists in Action, and many of the projects you will see exhibited here over the next two days.

Anyone who has reviewed items from the kinds of standardized tests given in most states will note the striking contrast between the kinds of activities students undertake in these projects and the content of the test items (Popham, 1999). This becomes a problem for classroom practice not only because teachers may feel anxious about devoting precious instructional minutes to technology-based activities that are not preparing students to do well on mandated multiple-choice tests but also because teacher-produced tests and other assessment practices are so strongly influenced by conventional practice in large-scale assessment.

Teachers (and our experience suggests, university faculty as well) tend to think in terms of multiple-choice and short-answer test items that put a premium on learning definitions for new terms, memorizing numbers, and distinguishing correct statements of facts or relationship from plausible-sounding distractors. The kinds of complex investigations, deeper understanding, and ability to apply concepts to new situations fostered by technology-supported programs like Hands-On Universe are difficult to capture with conventional test formats.

In many cases, teachers are attracted to approaches that actively engage students and hold promise for enhancing learning with understanding. Lacking familiarity with ways to test deeper understandings or higher-order skills, however, teachers often implement the activity without assessing what students are learning from it. The drawbacks of this omission are two-fold. First, students may not be acquiring the kinds of understanding the activity is intended to promote, and with no assessment of their level of understanding, the teacher is unaware of what they do not know. Barron et al. (1997) examined students' learning when their classrooms collected data on the quality of the water in a local stream. They found that when the teacher did not conduct assessment activities during the course of the water quality project, students went through the motions without understanding basic concepts. In an examination of classroom implementations of the inquiry-oriented Global Lab Curriculum, Young et al. (1998) found that many of the teachers who had students work in small groups to conduct the Global Lab investigations assigned only participation scores for that part of the class. Science grades were based on tests of the factual content in the textbook rather than on what students did in the course of investigations of the air, land, and water in their Global Lab study site. When this happens, students are receiving an implicit message about what is important—that which is graded—and the lack of teacher evaluation for their inquiry work suggests that it is "fun" rather than substance.

Lack of availability of assessments for higher-order and inquiry-oriented activities is a problem for researchers and evaluators as well. What is a project evaluator to do with a Technology Innovation Challenge Grant whose mission is to "encourage student inquiry" or "teach students to be change agents"? Scores on the Stanford Achievement Test (SAT-9) are unlikely to be affected, at least in the short run, by experiences supporting these goals. Thus, researchers and classroom teachers have a common stake in the development of assessment techniques and instruments more appropriate for the kinds of student-centered, inquiry-oriented teaching and learning we hope to support with technology.

Planning for a New Research Agenda

Despite the major investment of federal, state, local, and private funds in school technology, questions remain both about technology's impact on student learning and achievement and about how to implement technology within schools to maximize the learning benefits. The President's Committee of Advisors on Science and Technology (PCAST, 1997) called for an ongoing federally supported research program with complementary studies conducted by dozens of research organizations to provide "rigorous, well-controlled, peer-reviewed, large-scale empirical studies to determine which [technology-supported] educational approaches are in fact most effective in practice."

In 1999 SRI International received a grant from the U.S. Department of Education to support planning for a major program of rigorous, systematic educational technology research. In addition to commissioning research design papers from leading experts in research methodology, assessment, and learning technology, we have been involved in developing prototype technology-based assessments to help address the dearth of appropriate student learning measures available to inquiry-oriented, technology-supported projects. The remainder of this paper is a description of these assessment prototypes and of what we are learning from trying them out in classrooms.

We wanted our prototype assessments to capture skills that are not easily assessed with more conventional standardized tests and to demonstrate the capabilities provided by technology for doing more flexible, in-depth assessments. This is very much a look at work-in-progress as we are just half-way through the development and piloting process. Last year we did the initial design, development, and pilot work on the two technology-based assessments. Based on this early work, we are in the process of revising the assessments for further field testing this fall. While our assessments tap skills intentionally selected for their wide applicability, we have structured the two assessment prototypes as "templates," which will be modifiable to support the development of additional assessment tasks exemplifying the same approach.

Internet Research Task

Although word processing remains the most common application of technology in U.S. schools, Internet research is probably the fastest growing. On the national survey conducted by Becker and Anderson in the spring of 1998, 30% of teachers (and over 70% of those with direct high-speed Internet connections in their own classrooms) said that they had assigned Internet research tasks that school year (Becker, 1999). Given the fact that the proportion of U.S. classrooms with Internet connections rose from 51% to 63% between 1998 and 1999 (based on NCES statistics), we can extrapolate a commensurate increase in the frequency with which students' teachers are asking them to perform Internet research.

But what do students get out of these on-line research activities? And how do we know what they are learning? Our observations of classes conducting Internet research suggests that the nature of the research assignments, student skill requirements, and grading criteria vary markedly from class to class. We have seen classrooms engaged in long-term problem solving where the students figure out how to frame a problem, decide that they need a certain kind of data to support their problem solving, identify on-line sources of relevant data, analyze the quality and relevance of alternative data sources, and then pull down data sets for analysis.

We have also seen classes where the Internet task is more on the order of "find five facts about this country." Sometimes any fact and any source will do. Other times the task is so constrained, with teachers providing a small set of URLs and asking for fill-in-the blank type information, that students have little opportunity to exercise skills other than typing and copy-and-paste functions. Students may get graded on how many sites they accessed rather than on the judicious choice of information sources or important information.

The products students are asked to produce based on their Internet research are equally various. They run the gamut from lists of facts to conventional term papers to student's own interactive multimedia presentations or Web sites.

Standards-setting bodies—both those concerned with technology per se and those dealing with academic content areas—place an emphasis on research and communication skills. The standards of the National Council of Teachers of Mathematics (NCTM), for example, start with four process skills important at every grade level: problem solving, communication, reasoning, and connections (linking different subfields of mathematics and linking mathematics to other disciplines and real-world problems). The *Benchmarks for Science Literacy* (AAAS, 1993) assert that all students should possess the critical response skills of being able to judge the quality of claims based on the use or misuse of supporting evidence, language used, and logic of the argument. as well as communication skills. The International Society for Technology in Education (ISTE) asserts that "capable information technology users" are skilled at information seeking, analysis, and evaluation as well as communicating, collaborating, publishing, and producing. Similarly, the National Research Council (NRC) report *Being Fluent with Information Technology* (1999) argues that intellectual capabilities such as organizing and navigating information structures and evaluating information and communicating to other audiences are just as much a part of technology fluency as are basic information technology concepts and skill at using contemporary technologies.

Because we wanted our prototype assessments to be potentially useful to a wide range of classrooms and research settings, we concentrated on technology-supported research and communication skills. Unlike knowledge standards that are necessarily different from subject to subject and grade to grade, these "new basics" are widely applicable.

Approach. The assessment prototype presents an engaging, problem-based learning task that integrate technology use with investigations of an authentic problem. The student outcomes assessed include technology use (Internet and productivity tools), reasoning with information, and communication. The assessment prototype builds on technology assessments developed for the WorLD Links program evaluation (Quellmalz & Zalles, 1999). The current assessment prototype extends that earlier work by probing students' Internet skills more deeply and exploring issues related to administering the assessments on the Internet and scoring student work online.

The prototype assessment task poses the problem that a group of foreign exchange students wants to come to the U.S. for the summer and needs to choose one of two cities. (See Figure 1.) The middle-school version of the assessment specifies that the foreign students are most concerned about recreational opportunities and public transportation. The secondary-school version adds the health of the city's economy as a third criterion. Examinees are asked to research information about the cities, decide which city the foreign students would prefer, and then write a letter to the foreign students recommending that city. Students are given URLs for a set of real, complex Web materials for the cities of Knoxville, TN, and Ft. Collins, CO. In addition to finding information on the specified dimensions, students were instructed to evaluate the credibility of information on particular Web pages and to formulate a search query for finding additional, relevant information. Students were asked to compare and weigh all of this information in making their selection and to present the reasons for their choice when writing their letter to the foreign exchange students. The assessment was designed to require approximately two hours to complete.

Analytic scoring rubrics were drafted to rate students' technology use, reasoning with information, and communication. A generic scoring rubric was then tailored to develop item-specific scoring criteria for each version of the assessment. Exhibit 1 presents an example of question-specific scoring rules.

Pilot Testing. The middle school prototype was first tried out with four students. SRI assessment staff observed each of the students, encouraged them to think aloud as they responded to each question, and debriefed each student when the tasks were completed. The prototype was refined based on the "think alouds" and prepared for pilot testing with a class of 31 middle-school students from an urban school in which students had been using the Internet in class projects.

The secondary-level version was first tried with two secondary students. The "think aloud" procedures and debriefing informed revisions. The secondary prototype was then administered on line to 62 high school students drawn from four Virtual High School courses. Students logged on from 26 schools to take the assessment. In general, students were able to complete the task in the two-hour time frame.

Results. For the secondary-school version of the assessment, two raters scored the student responses independently, with agreement levels ranging from 84-96%. Results indicated that in general, students handled the search and word processing easily. Particularly revealing were the varieties of queries the students generated, the ways they interpreted the request to identify questionable information on the Web sites they visited, and their explanations of why they found certain information questionable. In general, students demonstrated greater proficiency at finding topically appropriate information than at reasoning with the information or communicating conclusions in a well-organized and thoughtful manner. Not surprisingly, we are finding relationships between students' prior experience with technologies and their scores.

Next Steps. Upon completion of the analyses, the prototypes will be revised and further field tested. In addition, we plan to use the Internet research template to develop a prototype on a new topic and to design additional questions related to Internet searching and organization of information. The on-line scoring function will be further developed to permit examination of student work by question or for the entire task. The scoring rubric will be refined and sample student work representing differing levels of quality will be selected to illustrate the scoring levels.

Palm-top Collaboration Assessment

One of the trends observed in many technology-using classes is a move toward more student collaboration and more teacher coaching as opposed to direct instruction (Sandholtz, Ringstaff, & Dwyer, 1996; Penuel et al., 2000). In student-centered classrooms, whether using technology or not, it's common to see students working in small groups to solve a problem or produce a product. The teacher in these classes can't be everywhere at once. How does he or she assess the quality of students' collaborative work? Our observations in Global Lab Curriculum classrooms, cited above, suggests that many teachers do relatively little to assess the quality of student collaboration in small-group work. Although the ability to work in teams is often cited as a critical workplace skill for the 21st century, most classrooms do little to enhance student skills in this area or help students become more reflective about their collaboration skills. When teachers do assess collaboration, the assessment is often simply a global measure of participation (or the absence of serious disruption) rather than a more nuanced assessment that includes the cognitive dimensions of working together to build a knowledge base or generate a plan, design, or product.

The challenge of assessing what is happening in multiple small groups within a classroom struck us as a suitable problem for taking advantage of the palm-top computer's portability. We wanted to explore the feasibility of having teachers performing "mobile real-time assessments" of collaboration skills as they move from group to group performing observations and offering suggestions. Initially, we envisioned our assessment as a tool for teacher use, but as our work unfolded, we decided to explore its usability for student self assessment as well.

Approach. We began with a review of the academic research on collaboration. The research base yielded a large number of dimensions of collaboration, as shown in Exhibit 2. We realized that the limitations of the size of the palm-top computer screen as well as the mental workload imposed by the requirement for monitoring the functioning of multiple student groups all interacting at the same time meant that we would have to be selective in terms of the number of dimensions that teachers rate. At the same time, we wanted to offer teachers enough options so that they felt the collaboration assessment would get at those features they think are most important. Accordingly, we began with a Web interface for teacher use in constructing an assessment tailored for his or her class. Figure 2 shows a screen shot of the prototype assessment-building interface. Under each dimension of collaboration, the teacher is presented with multiple potential assessment items (e.g., under the category of Forming Arguments, the teacher could select the item "Did group members back up their theories or ideas with supporting evidence?") that could be included on the tailored palm-top assessment. The teacher chooses those items he or she want to use and the resulting item set is down-loaded to the palm-top. (For our prototype assessment, we imported the assessment items into an off-the-shelf piece of software called *Survey Mate*.) It was necessary to pare down the item labels for the palm-top to avoid an overly cluttered screen. For each item, the teacher can observe each student group, rate the group on a simple three-point scale, and input the rating onto the palm-top computer. Exhibit 3 provides an example of a real classroom interaction and the way the students' behavior gets scored using the collaboration rubric.

Aggregated ratings for the whole class can then be uploaded onto the teacher's PC for classroom display (using the same Web site that supports assessment construction). Figure 3 shows a portion of such a display.

Pilot Test. We worked with a teacher of a nearby fourth/fifth-grade class to refine and pilot our assessment prototype. Working in an alternative public school, this teacher organizes most of his instruction around long-term projects and stresses the importance of student collaboration and students' ability to manage their own learning.

Before and after the use of the prototype assessment in this class, researchers administered a questionnaire concerning opinions regarding collaboration skills to the teacher and the students. We observed the teacher's use of the prototype assessment and then the use of the same assessment tool by the students themselves. Afterwards, we interviewed the teacher and the students concerning the usability of the palm-top assessment.

Results. Both the teacher and the students were able to use the palm-top tool. They felt comfortable both with the concepts in the items they were rating and with the palm-top interface. The teacher's ratings and those of the students generally followed the same pattern, but with groups earning higher scores on average from their teacher than they gave themselves. The teacher's interpretation of this difference was in terms of students' greater consciousness concerning effective collaboration processes when they knew he was nearby.

The pre- and post-questionnaire results suggested that there was some movement toward greater valuing of cognitive aspects of collaboration above sheer participation on the parts of both students and teacher. (See Figure 4.)

While providing the encouraging findings described above, the pilot test also revealed several limitations of the prototype. Although the teacher had picked the particular collaboration dimensions and items to score, once he actually tried to use them in the classroom, he found that they were not necessarily relevant to what students were doing at the time he was ready to rate their interactions. He wanted the capability to be able to modify the items to be scored "on the fly." Further, the research-based dimensions we used to organize the assessment items did not correspond well to the way the teacher thought about class activities. He indicated a strong preference for organizing assessment items by the type of activity (e.g., group research, planning, or design review) rather than by psychological dimension (e.g., developing social norms, assigning roles, or forming arguments). Finally, we found that some of the students were uneasy about being observed so closely. The challenge of attending to collaboration without raising the specter of "Big Brother" will need further attention. Our hope is that having students do more self assessment will mitigate this problem.

Next Steps. This fall we are redesigning the collaboration assessment with an organization based on student activity rather than psychological dimensions. We are also developing our own software shell to replace the off-the-shelf program that proved cumbersome for our purposes. The revised assessment will be pilot tested with five teachers to gain broader feedback on its usability.

Conclusion

While these assessment prototypes are still under development, they do offer illustrations of the way that technology supports can make classroom assessment of complex skills more feasible. One major advantage of embedding assessment within learning activities is the heightened focus on learning outcomes. Through the act of developing or choosing formative assessment measures, teachers must think about the kinds of skills and knowledge they are trying to impart through learning activities, and this reflection in turn supports better activity design and better articulation of learning goals to students. Research shows that the use of formative assessment as part of instruction increases learning (Black & Wiliam, 1998). Technology can make assessments of the kinds of skills needed for the 21st century knowledge economy more feasible—providing assessment tasks that mimic the features of real-world problems and providing portable, easy-to-use templates for collecting and storing classroom assessment data.

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Exhibit 1
Excerpts from Internet Research Task Scoring Rubric

URL Scoring

1: URL goes to a page from the wrong city, or from something unrelated, or has been entered incorrectly

2: URL goes to a page about the city in question, but not on the correct topic;

3: URL goes to a page on the same topic but not directly to the evidence (e.g., recreational opportunities, economy, public transportation) – (Note: use this if the student cites a topically-relevant URL but neglected to put in the evidence)

4: URL goes right to the page that contains the evidence, or provides a listing of the evidence

Evaluating Questionable Information

1: States that he cannot find questionable text, or the text he finds appears to be factual and he has not explained what he finds questionable about it

2: The student has found questionable text but has not tried to explain why

3: The student has found questionable text and has tried to explained why, but the explanation has some shortcomings

4: The student has found questionable text and has adequately explained why

Exhibit 2
Dimensions of Collaboration

Analyzing the Task

Developing Social Norms

Assigning and Adapting Roles

Explaining/Forming Arguments

Sharing Resources

Asking Questions

Transforming Participation

Developing Shared Ideas and Understandings

Presenting Findings

Exhibit 3
Scoring Classroom Interactions with the Collaboration Rubric

In one classroom session where we tested the assessment, we observed collaboration as groups of fourth- and fifth-grade students used their history textbooks to generate a list of causes of the American Revolutionary War. Members of one particular group were taking turns reading individual passages from their text aloud. When they finished, one student grabbed a pencil and asked the other students to write down what they read. Two students were particularly active in providing answers, and as an answer was given, the student with the pencil wrote it down. At one point, one of the students attempted to involve a boy who was not participating actively by telling him he had to give one answer. He reluctantly provided a cause for the Revolutionary War, but it was an answer the group had already generated. The three collaboration items the teacher had selected for the assessment can be applied to the behavior of this group. All but one member of the group appeared to take responsibility for getting the assignment done, so the "yellow" choice, "some students are invested" would be selected as the answer to the question "How much do group members feel accountable for the success of the task?" For the question, "Do group members give explanations for concepts or phenomena they are studying?" the students would be scored lower (be given the "red" score, indicating that no explanations were given that elaborated on the content of the text). None of the students elaborated on the text they were reading; they simply summarized the text out loud, and the student with the pencil recorded each answer as it was called out.

ED HOME EDTECH CONFERENCE 2000 *This page last modified August 25, 2000 (bay).*

Center for Technology in Learning

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CTL is ...
cognitive scientists, educational researchers, computer scientists, human-computer interaction specialists, and experts in network telecommunications. The Center also draws on staff from many specialties across SRI, including research engineers and scientists.

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CTL Based Research Projects

- Center for Innovative Learning Technologies
- Challenge 2000
- Effective Technology Use
- Evaluation Designs
- GLOBE
- Urban High School Reform

CTL People

Barbara Means

Co-Director, CTL

education
experiences
CTL research
publications/
papers
presentations

Dr. Barbara Means, Co-Director of CTL, is an educational psychologist whose research focuses on ways in which technology can support students' learning of advanced skills and the revitalization of classrooms and schools. In addition to directing ongoing evaluations of the technology-supported innovations GLOBE and Challenge 2000, she is currently involved in studying the interaction between technology and education reform efforts in urban high schools, and is addressing issues of research and evaluation design for the U.S. Department of Education. She is also a co-principal investigator for the Center for Innovative Learning Technologies, for which she co-leads (with Dr. John Bransford) the team is examining the potential of technology-supported assessments. Dr. Means' earlier work included directing the National Study of Technology and Education Reform, which produced the volume, Technology and Education Reform: Views from Research and Practice, published by Jossey Bass. She has also published the edited volume Teaching Advanced Skills to At-Risk Students (with Carol Chelemer and Michael Knapp) and Comparative Studies of How People Think (written with Michael Cole). Prior to joining SRI, where she serves as Vice President of the Policy Division, Dr. Means directed the Applied Cognitive Research Group at the Human Resources Research Organization. She earned her Ph.D. in education and intellectual development at the University of California, Berkeley and her bachelor's degree in psychology from Stanford University.

Education

- Ph.D. Educational Psychology
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Professional Experience

- Co-Director, Center for Technology in Learning, SRI International
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- Manager, Applied Cognitive Research Program, Human Resources Research Organization, Alexandria, VA.
- Assistant Professor
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CTL Based Research Projects

- Principal Investigator, Building a Foundation for Educational Technology Research , a grant from the U.S. Department of Education.
- Co-Principal Investigator, Center for Innovative Learning Technologies (CILT) , an NSF-funded center devoted to developing, implementing, and assessing technology-enabled solutions to critical probelms in K-14 science and mathematics educations.
- Project Director, Evaluation of the Global Learning and Observations to Benefit the Environment (GLOBE) program, in which students in K-12 classrooms worldwide are collecting environmental data for use by scientists. The evaluation of this innovative education program is using on-line teacher surveys, student assessments, and case studies of school programs to shed light on implementation issues and program impacts.
- Project Director, study of Technology supports for Urban High School Reform , case studies of innovative technology --using schools in two major cities, for the Joyce Foundation.
- Project Director, Evaluation of Silicon Valley Challenge 2000 , a joint effort by four school teams, high-tech business partners, and county offices of education. This consortium has been awarded a federal Technology Innovation Challenge Grant to provide coordination, teacher professional development, and curriculum design activities that will capitalize on the region's investment in a network infrastructure for its schools.
- Co-Principal Investigator, Distant Mentor Project. Studied ways in which software for remote collaboration can support learning over the network and collaborative problem solving between mentors and their less-experienced colleagues in the workplace, National Science Foundation.
- Project Director, National Study of Technology and Education Reform. Conducted case studies of schools implementing technology as part of a broader school reform effort, with a focus on schools serving large

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proportions of low-income students. Sponsored by Office of Educational Research and Improvement, U.S. Department of Education

- Project Director, study of models for teaching advanced skills to educationally disadvantaged students for the U.S. Department of Education

Selected Publications

- Means, B. (in press). Technology in America's Schools: Before and After Y2K. In R. Brandt (Ed.), ASCD Yearbook 2000. Alexandria, VA: Association for Supervision and Curriculum Development.
- Roschelle, J., Hoadley, C., Pea, R., Gordin, D., & Means, B. (in press). Changing How and What Children Learn in School with Collaborative Cognitive Technologies. To appear in The Future of Children, Special Issue on Children and Computer Technology. Los Altos, CA: The David and Lucile Packard Foundation.
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- Cole, M., & Means, B. (1981). Comparative Studies of How People Think: An Introduction. Cambridge, MA: Harvard University Press.
- Means, B., Chelemer, C., & Knapp, M.S. (Eds.) (1991). Teaching Advanced Skills to At-Risk Students: Views from Research and Practice. San Francisco: Jossey-Bass.

Selected Presentations

- Means, B. (April, 1999) Educational Technology, Equity, and Federal Education Programs. Testimony for the Senate Committee on Health, Education, Labor, and Pensions, ESEA Reauthorization Hearings.
- Means, B. (1999, September). Evaluating Technology-Supported Interventions. Presentation for the Stanford Learning Lab, Stanford

University.

- Means, B. (1999, June). Assessing Technology's Impact. Presentation for the State Technology Directors Meeting of the Milken Exchange for Education Technology. Santa Monica, CA.
- Means, B. (1999, May). Invited panelist for plenary Town Hall Meeting and for concurrent session, Equity and Effectiveness of Educational Opportunity, National Governors' Association Regional Forum on Transforming Learning Through Technology; San Francisco, CA,
- Means, B. (1999, March). The Future of Technology. Invited panelist, The Stanford Institute for Educational Leadership Through Technology, Stanford, CA.
- Means, B. (1998, December). "Technology as a Catalyst for School Reform," presentation for the Bay Area School Reform Collaborative (BASRC), Santa Clara, CA, December 1998.
- Means, B. (1998, October). "Technology in Education: Experiences and Prospects," presentation for the annual meeting of the Grantmakers in Education, San Francisco.
- Means, B. (1998, April). Models and Prospects for Bringing Technology-Supported Educational Reform to Scale. Paper presented at the annual meeting of the American Educational Research Association, San Diego.
- Means, B. (1998, April). Assessing What Students Learn in Student-Scientist Partnerships. Paper presented at the annual meeting of the National Science Teachers Association, Las Vegas.
- Means, B. (1997, October). Teachers, Technology, and Education Reform. Invited presentation to the Improving America's Schools regional conference, San Diego, CA.
- Means, B. (1996). Technology's Role in Reforming American Education. Presented at the World Bank Spring Training Conference, Reston, Virginia.
- Means, B. (1995, June). "Social and Organizational Supports for Schoolwide Technology Integration." Presentation for the RAND Workshop on Technology-Supported Student Learning, Washington, D.C.

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CTL People

Bill Penuel

Research Social Scientist

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CTL Research Projects

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- Joint Venture: Silicon Valley Challenge
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Dr. Bill Penuel is a research social scientist at the Center for Technology in Learning at SRI International. His research focuses on the assessment and evaluation of technology-based projects designed to support teachers, principals, and district administrators in implementing collaborative school reform initiatives. He is particularly interested in the study of how school professionals interpret and use assessment data in planning for these initiatives. Currently, he is working as an evaluator on the Joint Venture: Silicon Valley Challenge 2000 project, the GLOBE project, and the Joyce Foundation funded study of technical supports for urban high school reform. Prior to coming to SRI, Dr. Penuel worked a program evaluator on projects in San Francisco, Nashville, and Cobb County, Georgia public schools and as a business partner of the Learning Society Network at OISE/University of Toronto.

Education

- PhD, Developmental Psychology
  Clark University, 1996
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  Harvard Graduate School of Education, 1992
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Research and Professional Experience

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CTL is ...
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Selected Publications

- Penuel, W.R., & Davey, T.L. (forthcoming). Meeting the educational needs of homeless teens. In J.H. Stronge & E. Reed-Victor (Eds.), Promising practices for educating homeless students. Eye on Education.
- Penuel, W.R., Sherrill, B.M., Davey, T.L., & Allison, E. (in press). Meeting the educational needs of mobile African American males. In L. Davis (Ed.), Working with African American males: A guide to practice. Newbury Park, CA: Sage.
- Penuel, W.R. (1997). Between self and tribe: Revising some modernist notions for a postmodern world. Theory and Psychology, 703-710.
- Penuel, W.R., & Freeman, T. (1997). Participatory action research in youth programming: A theory in use. Child & Youth Care Forum, 26, 175-186.
- Penuel, W.R. (1996). Hearing different voices: Two languages in youth work practice. Journal of Child and Youth Care Work, 11, 84-94.
- Penuel, W.R. (1996). The authority of narrative discourse in youth work. In J. Knuf (ed.), Unity and diversity: Proceedings of the 4th annual international conference on narrative. Lexington, KY: University of Kentucky.
- Penuel, W.R., & Wertsch, J.V. (1995). Dynamics of negation in the identity politics of cultural Other and cultural self. Culture and Psychology, 1, 343-359.
- Penuel, W.R., & Wertsch, J.V. (1995). Vygotsky and identity formation: A sociocultural approach. Educational Psychologist, 30, 83-92.
- Wertsch, J.V., & Penuel, W.R. (1995). The individual-society antinomy revisited: Productive tensions in theories of development, communication, and education. In D.R. Olson & N. Torrance (Eds.), Handbook of education and human development: New models of learning, teaching, and schooling. New York: Basil Blackwell.

Selected Presentations

- Penuel, W.R. (1998, June). Collaborative technologies and shared workspaces: Transforming the activity of educational administration. Paper presented at the International Society for Cultural Research and Activity Theory. Aarhus, Denmark.
- Penuel, W.R. (1998, June). "I don't like to live nowhere but here": Place as a mediator of homeless youth's identity formation. Paper presented at the International Society for Cultural Research and Activity Theory. Aarhus, Denmark.

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- Penuel, W.R., Khanna, R., Kell, J., & Frost, J. (1998, April). School administrators' reasoning about data: An action research perspective. Paper presented at the Annual Meeting of the American Educational Research Association. San Diego, California.
- Penuel, W.R. (1998, April). Evaluation design for homeless education programs: A meta-evaluation of McKinney programs in Tennessee. Paper presented at the Annual Meeting of the American Educational Research Association. San Diego, California.
- Penuel, W.R. (1998, February). Supporting electronic collaboration about best practices in teaching and learning among school district administrators. Paper presented at the Society for Research on Adolescence Biennial Meeting. San Diego, California.
- Penuel, W.R. (1997, March). Organizational learning in the non-profit sector: Lessons from Girl Scouts. Paper presented at the Annual Meeting of the American Educational Research Association. Chicago, Illinois.
- Penuel, W.R. (1996, September) Contesting the history and affordances of cultural tools of identity. Paper presented at the Second International Conference on Sociocultural Research. Geneva, Switzerland.
- Penuel, W.R. (1996, September). A mediated action approach to cultural identity formation. Paper presented at the Second International Conference on Sociocultural Research. Geneva, Switzerland.
- Penuel, W.R. (1996, April). Mediation and participation in youth organizations. Paper presented at the Annual Meeting of the American Educational Research Association. New York, New York.
- Penuel, W.R. (1996, March). 'That's how they signify me': Identifying voices in youth organizations. Paper presented at the American Association for Applies Linguistics Conference. Chicago, Illinois.
- Penuel, W.R. (1995, April). Mediation in the life stories of youth in urban organizations. Paper presented at the Annual Meeting of the American Educational Research Association. San Francisco, California.
- Penuel, W.R. (1994, September). Adult guidance in development revisited: Identity construction in youth organizations. Paper presented at the International Conference on L.S. Vygotsky and the Contemporary Human Sciences. Moscow, Russia.
- Penuel, W.R., & Wertsch, J.V. (1994, July). Historical representation as mediated action: Tools for official or unofficial history? Paper presented at the International Conference on Cognitive and Instructional Processes in History. Madrid, Spain.

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White Paper

New Designs For Connected Teaching and Learning

Margaret Riel

■ Return to the Secretary's Conference on Technology 2000

Introduction

Technology is not the solution to the complex problems that face our schools but it can dramatically increase the community of participants designing solutions.

Fundamental change in the next decades will result from participation in education by a larger community of people who the Internet brings together, rather then from access to technology. This is because education is a human enterprise. It is dependent on the relationship between teachers and learners in a specific social, political, and historical context. My paper focuses on this context and way in which changes to the learning environment alters the relationships between teachers and learners, and between school and society.

The paper is divided into two parts. The first section examines current theories on learning and their relationship to the educational context of school. I frame my ideas on learning by using four dimensions of the learning environment identified in a book entitled *How People Learn: Brain, Mind, Experience and School*,edited by John Bransford, Ann Brown and Rodney Cocking (NRC, 1999).

They describe the learning environments as:

Learner-Centered	Knowledge-centered
Community-Centered	Assessment-Centered

I describe the intersection of these dimensions of effective learning contexts with the opportunities made possible by access to communication technology. Where there is a lag between innovative practices and research evidence, I describe examples of how the Web is affecting student learning in specific settings.

These factors define the context of learning for teachers as well as students. The role of teachers change when there are significant shifts in the organization of the learning environments, the orientation of learners, and availability of instructional tools and technology. These changes call for new roles for teachers.

In this second section, I focus on the relationship of teaching and research, historically and in the present time, relying on Lagemann new book, *An Elusive Science: The Troubling History of Education Research* and Berieter's online book: *Education and Mind in the Knowledge Age*. I also use data from the recent *Teaching, Learning And Computing: 1998 A National Survey of Teachers and Schools* to describe levels of professional engagement of teachers and its relationship to teacher philosophy and practice. This data suggests that professionally engaged

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teachers differ significantly from classroom teachers who are isolated in a "private" practice in their classrooms. This data, I argue, should open some serious concerns over a structure that encourages closed classroom doors. We need plans to make teaching a much more collaborative community activity.

I close with some new ideas for how to create learning environments for students and teachers that balance the four dimensions of learning. These ideas are offered in the spirit of a collective rethinking of schooling in the context of evolving understandings of learning and our rapid advances in the development of tools that mediate minds.

Interactive Learning Environments

Educational goals are tied to learning environments, as one changes so must the other. Literacy goals 100 years ago for many students were to be able to read and write names, copy and read texts, and generate lists of merchandise. Literacy goals of today require mastery over many different genres of writing, persuasive, expressive, expository, procedural and expect students to be able to interpret, compare, contrast, and analyze complex texts. These differences in learning goals also hold for mathematics. Students learn the mathematical foundations necessary for careers that did not exist 100 years ago. There has been exponential growth in the amount of recorded knowledge so that memorization of factual information is no longer an effective approach to mastery of a field.

Conceptions of learning have also shifted with a century of research on learning and teaching. The developmental, experiential, and philosophical notions of learning described by John Dewey and George Herbert Mead in the early years of the past century gave way to individual, behavioristically oriented conceptions of learning based on the early work of Edward Thorndike and extended by B. F. Skinner. Mid century, theories of knowledge construction by Jean Piaget contrasted sharply with those of Thorndike and Skinner. In the last two decades, beginning with theories of multiple intelligences by Howard Gardner in the 80's and followed by advances in cognitive science, educational research, and understandings of the neurological functioning of the brain, our understanding of learning continues to develop. The current conception is of a more constructivist process with a much stronger focus on the interactive processes. These changes over the past few decades are detailed in *How People Learn: Brain, Mind, Experience and School*, the 1999 report of the Committee on the Development of Learning Sciences to the Commission on Behavioral and Social Sciences. The entire book is available on the Internet. It describes effective learning environments as the integration of four dimensions.

Effective learning environments are...

Learner-Centered	Knowledge Centered	Community Centered	Assessment Centered

Learner-centered because we need to engage learners with their own goals and a willingness to construct new knowledge. Learning is a basic human function; however, it is very difficult to teach something to someone who does not want to learn. Unfortunately, many of the students in our schools have made "not learning" their primary work. Without student interest, learning proceeds at a very slow pace, if at all. When teachers are the learners in workshops or institutes, these contexts need to be learner-centered as well.

Learner-centered implies that the learner is actively engaged in the process of knowledge construction. Learning is an active, exciting process that can be difficult, frustrating, and

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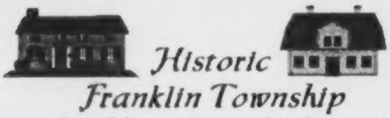
challenging but is not inherently boring. Boredom sets in when learning is reduced to repetitive actions or assignments that are disconnected from larger goals or contexts. Skill development requires some amount of practice but practice is motivated by performance. The player who shoots baskets or blocks shots in practice has visions of how these skills will play out in the next game. The game provides the attitude and motivation to practice hard.

In the context of the classroom, performance is often reduced to memory exercises on tests. When students are engaged in projects, teachers often feel constrained to limit student choice to topics which can be well investigated with the resources available in the classroom, or in the school or local libraries. This restricted range means that teachers will be reading repetitive papers each year. Students know that this writing is simply an exercise, their teachers are not reading their writings for content and ideas but rather to evaluate the form of the writing. For many students and teachers, there is a disconnect with students redefining the task as writing "what the teacher wants to read."

With the growing informational and human resources on the Internet, a student, with access, can find a wide range of materials on almost any topic. If students have more latitude, in both the topic and resources selected, it is more likely that they will be able to create original knowledge products. More important than choice is an audience that is interested in the outcome of their research, development or insights. Research has demonstrated that authentic tasks with real audiences have resulted in increased learning, stronger writing and longer retention of learning and even increased performance on standardized tests of writing. But more than test score results, students engaged in building knowledge products for others develop a sense of purpose and value. They contribute to their community.

Thousands of teachers in classrooms across the country are using the Internet in project-based learning to engage students in authentic tasks. I am going to briefly profile two teachers for the following reasons. First, these examples describe meaningful contributions of students in first and fourth grade. This is offered in contrast to those who argue that young children are harmed by early use of technology. Secondly, in these classrooms, learning has been completely organized around meaningful projects. These are not isolated projects that succeeded. These teachers have shifted the way teaching and learning is organized. Finally, these teachers have themselves demonstrated a remarkable process of learning across many years and their learning has been matched by improvements in students' performance on all measures. These changes did not take place in a single year. Research suggests a 3-5 year period for teacher change to affect student skill. My experiences with teachers suggest that it is closer to the five year time period. Change takes time.

Kristi Rennebohm-Franz's first grade students in Seattle take on new projects each year in social studies, math, history, and science. For example, as part of their instruction in science, seven years ago her students started studying a pond. Over the years each group of students have monitored the pollution and measured a decrease in the duck population and other signs of problems. Her students became local advocates for social policy to solve the problems and have succeeded in having the pond preserved as a natural habitat for the ducks.



Barry Kramer's fourth grade students live in a farming community in New Jersey but actively use the Internet to extend learning beyond the classroom. Barry's students engage in a number of international projects in Learning Circles each year. But his students also learn local history through their efforts to preserve and share it. Each year, his students develop research, writing, interviewing, and Web design skills while providing a public service. They create Web page "case studies" of historic sites and local farms. The students work with a local historian who assures that the information that they collect and post is accurate. They learn to double check their sources as well as work hard on their editing. They know that their work is important to others, and not just an exercise.

Kristi's and Barry's classroom Web sites are testimony, in themselves, as to how the Internet can reshape education. Their students arrive with little or no experience with technology. Instead of focusing on computer literacy skills, the students use the technology to accomplish important educational goals. They join in a process of making knowledge products. In creating external documents of their work, they are much more engaged. Kristi's first and second grade children gave the Keynote presentation at the IEARN international Conference. This "exhibition" of their skills was very impressive. Barry's students begin creating very simple Web designs, but at the end of the year they are able to incorporate multimedia into their sites. But learning to use the technology is not the goal. Barry knows that the technology will change many times before his students see the workplace. Instead he spends his time teaching them to interview, write, check and recheck sources. But what is most important is the relationships that develop between the students and other adults in their community.

The ThinkQuest Internet Challenge offers a different structure for organizing learning that is modeled on group project development common in today's business world. Students tackle the problem of teaching a subject or skill to their peers. Team building is an important part of the process and this contest rewards diversity of perspectives so team members often come from different countries, or bring very different background experiences to the group. The team finds coaches and works on a time line to bring their knowledge products to completion using Internet tools for both communication and design. The sites are made available on the Internet and the designers are challenged to locate, inform and support a community of learners to use their sites for learning. This process is the final part of the contest. Will students utilize their resources and activities? Is there evidence that learning is taking place as a result of interacting with their sites? The students compete for college scholarships but there are many more winners than the finalists. All of the students who participate learn a great deal and millions of students and teachers benefit from the materials that are created. Students are creating the Web's largest library of freely available learning activities. And the ThinkQuest library continues to grow in size and quality every year. Students teaching other students is one of the most valuable untapped educational resource available in and for schools.

Capitalizing on students' personal learning interests, encouraging them to develop their own skills to find, synthesize and use information in creative ways, provides a much richer learning experience for the students as well as the teacher. When students use the Internet to find resources that are new to their teacher, develop original projects, and find other people to help them with their work, they are engaging in an important process of constructing rather then receiving knowledge. Internet resources constantly change. So even if students are pursuing a similar project to that of students a year ago, there may be very different materials available. Helping students to become "knowledge scouts" looking for new materials to extend lessons is a renewable educational resource.

Generation Why, developed as a U.S. Department of Education Technology Innovation Challenge Grant, is a project where school students work as knowledge scouts to help their teachers redesign lessons with technology. The goal is to enlist student help to think about alternative ways of structuring learning. The teacher helps the student understand the goals and objectives of the lesson and then the student uses their network of online consultants to create a new way to accomplish the goals. The student coaches the teacher in any new technology skills. Students bring knowledge of technology, time to explore the Internet, and their network of social resources; while the teacher brings an understanding of how ideas might be adapted to fit into the classroom structure. Together a teacher-student partnership creates a lesson that addresses the changing needs and interests of students.

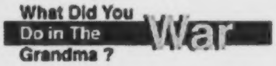
Effective learning environments are...

Knowledge-Centered

Knowledge-centered because the ability to think, reflect, and solve problems is strengthened by access to ideas, assumptions and conceptions of others arranged in meaningful ways. Many teachers work very hard to reach and teach their students. This means continual learning of curriculum content as well as methods of instruction. Yet teachers have little time for this form of professional engagement.

Knowledge-centered learning highlights the important role of the teacher in setting the "course" of learning. Over the past century of curriculum development, discipline-based groups have contributed many effective ways to organize essential skills and knowledge. But knowledge building is not a finished activity in any field. Textbooks reduce multiple perspectives to a simplified consensual viewpoint at a fixed moment in time. These secondary sources present knowledge as non-contested facts with less attention to the community debate, the historical discoveries or analytic reasoning that historians employ to come to their conclusions. In the past, it was not realistic to expect students to find primary sources. The Internet changes the relative value of textbooks. Students, like historians, engage in real research, interviewing people who were involved in historical events, accessing real documents, and using them to understand, draw conclusions, and debate different perspectives. Here are three examples. The first one is a ThinkQuest project and the other two result from a collaboration between South Kingstown High School and Brown University's Scholarly Technology Group. All three of them involve students becoming historians collecting and preserving historical data.

HOLOCAUST
LEGACY



1968
The Whole World
Was Watching

Curriculum research and development was the university's solution to poorly trained teachers. Some researchers overtly sought to design curriculum that could be "teacher proof." The knowledge, they hoped, would be learned directly from the materials. But technology has never replaced the teacher for one simple reason. Teaching is an emergent, interactive constructed activity that requires a complex blend of knowledge of the students and knowledge of the curriculum.

The Internet, like a textbook, is a valuable source of knowledge that can help in the process of making decisions about what and how to teach discipline knowledge. The Web can help provide AskERIC teachers the structure of discipline knowledge to help them design cognitive roadmaps to organized learning, project ideas for developing students research and thinking skills, and assessment tools to evaluate student achievement. ERIC, the Academic Guide to the Internet, the Annenberg/CPB Projects Exhibits, the Math Forum, Marco Polo and the United Nations CyberschoolBus are examples of sites that archive large databases of informational resources, partners and projects.

Our knowledge is contained not only in what we write but also in the way that we preserve and share what we learn. The Internet brings centuries of discoveries (telescopes, microscopes, transmitters, receptors, recorders, light, camera, sound and action) together in the digital context and makes them available for student and teacher use. Some examples:

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The Internet has thousands of opportunities for collaborative projects. With Webcam and video, very young students can watch the behavior of hamsters throughout the day and night. As partners with scientists at the Center for Biological Timing, students' natural curiosity is extended to scientific observations and analysis. Students are invited to "view live images and actual experiment results, analyze real-time data, form hypotheses, suggest variables for new experiments, and share conclusions with other scientists from all over the world."

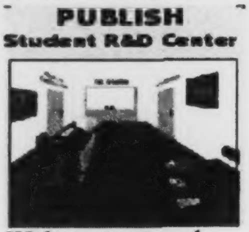
Elementary students are using electromagnification to examine mouth parts of bugs to understand how animals digest food. They use these sophisticated tools from a distance to see what is invisible to the human eye. The Learn and Live Digital Toolkit describes how a video-conferencing project between a school five miles from the Mexican border and a major University miles away helped students to learn by using the technology to amplify the power of their eyes. The video details a different way of organizing learning using video-conferencing to bring to students intellectual content and tools that are beyond what is available in the classroom.

Middle school students across the nation were collectively awarded time on the Hubble Telescope in 1996 and used the Web to facilitate their project. Scientists were available on live television broadcasts to work with students in selected classrooms. With communication technology, any student or teacher watching the program could send their questions by email or fax during the broadcast. Students read, organized, and then summarized the questions as they were received for immediate feedback from the scientists. This increased the level of participation of the students and provided access to specific expert knowledge as students viewed their data from the telescope.

This is only one of hundreds of electronic field trips; opportunities which take students places they could never reach by bus. Last spring, The Jason Project provided live streaming Internet broadcasts of the JASON XI expedition, originating from NASA's Johnson Space Center and NOAA's Aquarius underwater research lab. (Past adventures can be revisited via on-demand, archived videos on the Internet). For students who cannot make the trip to Washington, D.C., they can tour the White House, visit Congress, and explore the Smithsonian Institution. They can also compare the U.S. government with that of England by a visit to #10 Downing Street in London.

PBS recently sponsored online "time" travel to Williamsburg of the 18th century where students could be part of early congressional debates and vote online. Current online activities, building on the televised program *Order in the Court: Juvenile Justice in the 18th Century,* deal with colonial justice . Connecting television with net forums, discussions, and online activities makes it possible to create a much richer representation of our history and its relationship to the present and future.

High school students explore the ocean floor with videotapes transmitted from remotely operated vehicles in the Monterey Bay. The Virtual Canyon Project makes it possible for them to see the same primary data that scientists use to do their work. This project links CD research tools with Web Community publishing tools.



University students are using 3-D virtual worlds combined with Web sources and moving representations of participants to create inhabited virtual learning spaces.

These representations-avatars-can walk, talk, move, point, jump and teleport to new locations. Virtual universities and high schools are using these new communication and Web tools to provide for the range of experiences, both social and intellectual, that are a vital part of the learning. These virtual worlds can be seamlessly integrated with web pages extending the possibilities for interaction in many domains. Educational conferences have been held online in active worlds. The University of California, Santa Cruz team built a demo high school in Active Worlds as an example of how college preparatory courses could be offered online.

Teachers have access to materials to help augment any subject or concept they want to teach. The California Learning Exchange is one of many sites that is taking advantage of video to demonstrate quality teaching and learning. One video, shared by the Orange County Department of Education, illustrates how to teach pre-algebraic concepts to an elementary ethnically diverse class of students. Knowledge-centered learning does not, as is clear from watching the video clips, mean drill and practice of math facts. Watching a master teacher work with a group of students provides for deep discussions about teaching and learning.

When the network is viewed as curriculum resources, the issue shifts from finding enough information to understanding how to relate different sources of information. Students, as well as teachers, can compare perspectives from different groups and come to terms with intellectual authority.

- Who has the right perspective?
- Whose perspective has been or should be central?
- What are the grounds for making these decisions?

When students (as well as teachers) are building knowledge through working with peers and experts, they encounter the same problems. With multiple sources, they must face and participate in the social process of knowledge building. If one source says that killer whales are really dolphins and another lists them as whales, who is right? If one research project shows students writing test scores increasing when they are engaged in authentic projects with real audiences and another shows that grammar drills led to high scores, which program should a teacher implement? How does one find the "right" answer or know when an answer is believable? What are the ground rules of evidence, inference and theory building.

In the past, multiple sources of information were collected, analyzed and summarized in textbook treatments of issues. The arguments are settled, the central positions are displayed, and the student's (and sometimes the teacher's) role is to accept the authority of the "correct" account. All knowledge is created and it is in the process of creating knowledge that should be a major focus of our classroom learning. When students and teachers are engaged in creating the "shared" understandings, they are learning to be a part of the knowledge society.

The challenge of the knowledge-centered dimension of learning is to balance knowledge construction activities with activities that help students develop the suite of mental tools needed for this task. Basic skill development is an important dimension of knowledge building. When these skills are placed in the larger context of authentic learning tasks, they are acquired more efficiently.

Effective learning environments are...

Community-Centered

> because many more people can and should be part of the learning processes that take place in our schools. Many of our schools are massively underfunded. The physical conditions of schools communicate to students the value their community places on their future. Active involvement of the community in schools can transform the learning experience.

Community-centered is one of the most critical dimensions of the learning environment. A community of learners is distinctly different from a classroom of learners. The differences are described in more detail in an article by Fulton and Riel in Edutopia.

A learning community is a group of people who have:

- A shared interest in a topic, task, or problem
- Respect for the diversity of perspectives
- A range of skills and abilities
- The opportunity and commitment to work as a team
- Tools for sharing multiple perspectives
- Knowledge production as a shared goal or outcome

At the beginning of the 20th century, students had access to their teacher, the other students, and if they were lucky, some books, and community plans or "standards" for education. Throughout the century, concerns have been raised about the quality of schooling, the nature of teaching and learning, and the function the school plays in society and the role of society in schools.

Early concerns about the quality of teaching focused attention on the need for better teacher preparation. Teacher education was moved from secondary and "normal" schools to education departments in colleges and universities. The curriculum was the focus of reforms in the 20's, 40's, 70's, and most recently following the poor showing of the U.S. students in international testing, in the 90's. The call for national standards is offered as a partial solution for uneven or poor quality teaching.

Conceptions of learning also shifted dramatically over the century from philosophical debates over nature and nurture, to psychological focus on control of rewards and punishments to current cognitive and sociological emphasis on knowledge reconstruction within social-cultural-historical contexts.

Reform efforts have also extended beyond changes to teaching, learning and the curriculum to address the extreme differences in the differential distribution of educational resources. National strategies for improving equity in educational opportunity have been implemented with partial success over the past 50 years beginning in earnest with desegregation efforts and federal policies and programs.

But perhaps one of the shifts that is not so clearly recognized is a change in the function of schools. Schools of the 20th century were designed to serve a sorting function sending forward only those students who had the ability to succeed at intellectual work. School learning was only one of many avenues toward meaningful participation in society. Today the need for intellectual skills has multiplied so rapidly that school success is necessary for entry into most positions in the workforce. So, for the first time on a massive scale, there has been a movement to hold teachers accountable for the learning of all students, not just the students in the college-bound tracks.

Educating all children is a fundamentally different enterprise and cannot be done in the same structure that was designed for educating those who have extensive intellectual and financial resources at home. This new equalizing function requires more from citizens than their tax dollars. Public schools need intellectual investments from citizens.

The community of learners are important resources and schools differ in their access to human intellectual resources. Equitable access to human intellectual resources is at the heart of the focus on learning communities. Technological advances over the century have made it possible for hundreds of thousands of people to extend their intellectual resources to teachers and students in the classrooms. They participate in classroom learning through their books, posters, films, movies, science kits, math manipulatives, models, photographs, computer programs, and writing technology. Their participation, not the technology, is what is changing schooling.

Internet technology makes it feasible to exponentially increase the community of people involved in education. Students can spend time teaching and learning from people who could not visit their class. These first two communities predate the Internet, and have involved students in project based online for nearly two decades. The third example illustrates the intersection of community building Web tools with educational communities focused on professional development of teachers.

The International Education and Resource Network (IEARN) is a community of students and teachers from over 90 countries who are joined by a spirit of social responsibility for, and a sense of collective purpose to solve, global problems. IEARN teachers sponsor over 50 international projects designed to help embed the learning of academic content --history, geography, math, art science and social science within activities that have purpose and meaning in the lives of students around the world. The Holocaust/Genocide Project, with links to Facing History and Ourselves helps students face problems of intolerance, prejudice, racism, and bigotry by exploring history and current events in order to take "action" together for nonviolent solutions to these problems. The Global Art Projects provide a visual forum for exchange of ideas around themes (Faces of War, Coloring Our Culture). The contact through art often leads to social action projects with local and global dimensions. Learning Circles provide a structure matching classrooms from around the world into groups of 8 (circles), and supports a process where students participate in projects drawn from the curriculum of each participating school. In all of these project students "making a difference" through concrete outcomes -- not only project based learning but *product-based" learning. They publish their social/environmental project work in both online and print magazines and journals.

Learning Circles
Guide Overview

The Global School Net (GSN) is a community of teachers who have been exploring new forms of tele-learning since 1984. Beginning with a small offering of collaborative projects, they pioneered the use of video-conferencing in education, and hosted a project registry to help schools find partners. With the help of corporate sponsorship, this grass roots community develops the CyberFair Contest and the GeoGame. Their current partnership with Lightspan adds more communication tools, and professional development resources to promote community building.

Most people do not know how to support learning, either face-to-face or online. Adults are often too eager to share their skill and knowledge without reflecting on the needs of learners. Learners often have access to information, but they lack the knowledge of how to use that information in productive ways. To help students make sense of new information, they need help in connecting it to what they know and then extending their knowledge in new directions. Master teachers could serve a valued role in helping adults learn to work with students, and students learn to work with adults who have a depth of knowledge in many different areas. Since teaching is a needed parental skill and workforce skill, helping adults learn how to participate in classroom teaching and learning could have valued secondary effects.

Mentoring projects on the Internet add the interactive presence of many new people in classrooms--authors, scientists, designers, developers, mathematicians, and community leaders. With communication technologies it is now easier to create environments in which students can learn by doing, receive feedback from peers and outside experts, and continually refine their understanding to build new knowledge.

And finally, the Internet is making it possible for conferences like this one to be experienced by people who could not travel to Washington. It transforms the verbal context of a conference into a written event that leaves an intellectual footprint that can be followed years after the event. The development of the Department of Education Website is, in itself, a perfect example of the transformation that is taking place as we move from an information sources to community building tools.

Effective learning environments are...

[redacted]	[redacted]	[redacted]	**Assessment-Centered**

> **Assessment-Centered** because knowing what students are learning and what they need to know is critical information for shaping learning environments. When students don't learn, the community suffers. High stakes testing only makes clear the dimensions of the problem. Assessment that is ongoing and prescriptive can help make every student a valued member of society without the negative affects of ranking schools.

At the beginning of the 20th century, IQ tests were celebrated as a fair way to classify and then sort students into educational categories or tracks based on talents that many assumed were genetically determined. When children had learning difficulties, they are referred to a school psychologist who uses a range of IQ and achievement tests to locate the source of the problem. It was assumed from the outset that the child "owns" the problem. He or she is said to *be* learning disabled, a slow learner, or have an educational handicap.

Recent neurocognitive research suggests that the richness of early learning experiences affects the physical development of the brain and may be a major cause of intellectual development. If these new theories linking learning experiences with brain development come to be accepted, the optimal match between characteristics of the learner and the learning environment, rather than parental genetic code, might be seen as responsible for school success.

The narrow context that we currently call school is effective for some students, but if the task is to educate all children, it may be necessary to restructure the learning environment. It might be time to replace school psychologists with school sociologists prepared to view learning problems in terms of a fit between the conditions of learning and the needs of learners. The school would share ownership of the problem and the solution would be to find a more optimal learning context. New forms of assessment would be necessary to understand the fit between the learner and the context and the teacher.

Students learning in most schools are currently assessed by short-answer, quick-timed, standardized achievement tests. Much less effort has been expended on matching these tests to curriculum standards. Instead they serve to reward schools with children from high socioeconomic backgrounds and threaten schools who face the most challenging social problems.

The Internet contributes to assessment in the following ways:

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- providing research summaries
- by serving as a discussion forum
- increasing access to resources such as reports and videos
- disseminating information on new strategies for classroom assessment
- Test preparation and online test taking

Digital portfolios created by students and teachers can be found on the Web accompanied with a rationale for why this process is so important to learning. Students can also find structured help to prepare for high stakes SAT testing. And the Internet provides instant access to the results of high stake testing at the state, national and international levels.

For the most part, however, using the computing power of the Internet to design new forms of student and teachers assessment is in its infancy. The research tools listed on this conference website are each, in their own way, moving us ahead in this process.

Another development that is not listed is the use of computing power to assess the quality of writing. Latent Semantic Analysis (LSA) is a mathematical/statistical technique for evaluating written text by extracting and representing the similarity of meaning of words and passages. Knowledge Analysis Technologies is currently exploring ways of making this technology available in a program called the Intelligent Essay Assessor. A tool like this used by students to evaluate the quality of their work could provide important feedback for editing and revision. Students often feel that their grade is a subjective assessment of how much their teacher likes or dislikes them. The Intelligent Essay Assessor is currently being used with some success to improve the writing of undergraduates(Foltz, Laham, & Landauer, 1999). I have some concerns that the underlying matching of students work to content text or expert essays will fail to reward metaphorical writing but, even with this concern, I think that this type of tool under the control of the students could be very useful. Even if these tools for understanding a good conceptual essay are not foolproof, they can provide a way to examine, discuss and compare writing samples of k-12 students (Stahl, dePaula, and the LSA Research Group, 2000).

Instead of investing our time and resources in high stakes testing that simply ranks schools, we need assessment tools that can be used throughout the school year to monitor both individual and group learning. Not pencil and paper tests, but tasks that require thoughtful work, provide multiple paths to problem solving and promote deep understanding. Participation in these network activities can be analyzed for evidence of student achievement and these records used for student and school report cards. In this way learning and testing are complimentary components of the same process. SRI International is developing some interesting prototypes for new forms of assessment that are described in *Developing Assessments for TomorrowÕs Classrooms*.

Professional Teaching

The role of teachers is critical in the human enterprise of education. Teachers serve as bridges connecting students to the curriculum, and the student to the community. They evaluate the relationship between the curriculum and student progress; and, they determine how this progress relates to community needs. In the terms of the dimensions discussed, they create the alignment between learner-, knowledge-, community-, and assessment-centered learning.

Technology can support learning and in doing so will require a readjustment of the relationships; but the act of balancing these needs is a complex human activity. It is the essential role of the teacher. The teacher charts and recharts the course of education as the nature of the learner changes, as the knowledge terrain evolves, as community involvement increases, and as learning expectations shift. Teaching is, by its very nature, an improvisational activity that requires complex cognitive processing of many competing factors. Teachers need to be continuous learners and researchers. They need to play active roles in knowledge construction--both as a means of learning and teaching.

Research and Teaching

The development of teaching as a profession and the field of educational research have not been closely aligned. Teachers have little time to contribute their observations and knowledge about how students learn or to document the best teaching methods. Researchers are often driven to answer questions that are not immediately useful to teachers.

Historically, Lagemann (2000), argues that the early feminization of teaching coupled with the exclusion of women from most colleges contributed to the split between research and practice. Women were seen as naturally fit for teaching because of their deep understanding of children. But, at the same time, there was a belief that women lacked conceptual skills. This was mitigated somewhat by providing them supervision by male principals and administrators. Teacher preparation took place at teaching institutes, normal schools and academies. With the advent and rapid growth of high schools in the 1890's, teacher education moved from normal schools to high schools but continued to attract women from working class backgrounds. At the turn of the century, efforts were made to move teacher preparation to the college and eventually to graduate study at universities. This was done to provide a better education and to attract teachers with a stronger intellectual orientation. But with increasing options open to women in the later part of the century and limited career advancement in teaching, this goal continues to be difficult to achieve.

Beginning with the Carnegie Foundation for the Advancement of Teaching in 1905, universities have viewed themselves as positioned at the pinnacle of a pyramid with K-12 education providing the base. Many of the curriculum reform efforts of the last century have been expressly aimed at diminishing teacher initiative or as a way to address uneven quality of teachers. Curriculum reformers in the 30's and 40's establish a "scope and sequence" of curriculum to constrain teacher choice. Curriculum researchers in the 60's overtly tried to design curriculum to be "teacher proof." The effort to develop curriculum standards, with minimal input from teachers, is a current strategy to place decision making outside of the classroom.

While researchers and educational reformers developed programs, often with new technologies, to increase learning, these programs were not adopted by classroom teachers. These failures fueled complaints about teacher quality and their lack of conceptual understanding. Cuban (1986) chronicles these cycles but also faults researchers for not achieving a balance among complex learning dimensions of classroom instruction. Whatever the cause, the gulf between educational research and educational practice continues to challenge the development of a science of education (Lagemann, 2000). Berieter (1999) suggests that the solution is to be found in new institutional relationships:

> In order for education to become a modern profession it must be able to generate knowledge--knowledge that sustains progress in the tasks that constitute it as a profession. Educational research has, in the last few decades, begun to acquire that capability, but there is a deep cultural split between it and educational practice. A similar split existed in medicine during the 19th century, but it gradually closed as practitioners became increasingly aware of the nature of unsolved problems, came to see the advancement of science as vital to their practice, and eventually came to see themselves as part of an advancing scientific discipline. Nothing like that has happened yet in education. (Berieter, 1999, Chapter 11)

It cannot fall only to teachers to be the bridges across this divide as Berieter indicates. There have to be changes in the educational community that create opportunities for a richer engagement of teachers and researchers in a professional community--a community which seeks to understand and create the most effective learning environments for students.

Professional Engagement and Teacher Leadership

While teachers often resent control by administrators, university researchers, and political leaders, the field has yet to develop a strong, self-regulating professional community (Lagemann, 2000). This is partly because the structural organization of teaching leaves little time for building community. However, using survey data it is possible to answer some questions about both the philosophy and teaching practices of the nation's most professional engaged teachers.

A national survey, Teaching, Learning and Computing, 1998, collected data on 4,000 teachers with extensive sections on teaching philosophy, teaching practice, computer use, educational background, and engagement in professional activities. Riel and Becker (2000) used this information to identify a subset of teachers who indicated a high level of professional engagement beyond the classroom and beyond the school. These were teachers who had been identified as teacher leaders (representing about 2% of the teachers in the nation) by both local and distant educators. They mentored their peers either formally or informally, attended and spoke at conferences, served on committees or exchanged email with teachers in other schools, and may have published articles or worked in partners with university teacher education programs. At the opposite end of the professional engagement axis were teachers who had minimal contact with teachers outside of their classroom and engaged in teaching as a "private" practice. This group represented 58% of the teaching population.

The contrast between these groups is striking. Teachers leaders view teaching and learning as a co-constructive process in which students are asked to think deeply about issues, generate their own ideas, work collaboratively in projects, and share and evaluate their work within a public classroom forum. These teachers, as a group, have made and continue to make a much stronger investment in their own learning. They are teachers who were more likely to have attended select universities, earned higher grades in school and received more graduate degrees. They spent twice as much time in professional development than do private practice teachers. In contrast to teachers who remain isolated in their classrooms these teacher leaders were **ten times** more likely to also be among the leaders in the use of educational technology--a very dramatic finding. The use of computers, as well as their goals for computer use, again indicate that these educational leaders have a very strong passion for constructivist learning that is congruent with the dimensions that have been described in this paper.

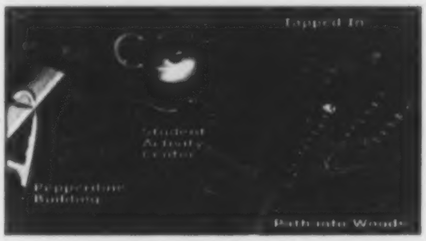
The overall finding is that there is a clear match between the relationship of the teacher to the educational community. Those teachers who are actively engaged in learning and leading, who have developed a voice that extends beyond the classroom to a professional community are more likely to engage students in knowledge construction in the classrooms, encouraging student voice in presentations of their ideas to classroom community. Those teachers who are isolated from a professional community, who are only recipients of knowledge, teach in ways that isolated students, and stress information reception and recitation.

Professional Communities

Expert teacher knowledge of teachers is not routinely recorded, negotiated, and stored in community spaces for use by new members of the community. Web technology tools make it possible for learning partnerships among educators at schools and universities to work together to create professional communities. Many efforts are developing both across fields and within disciplines. Unlike the curriculum projects of the past, these efforts are not developed and delivered, over the Internet, to teachers. Instead they are invitations for teachers to join educators from different sectors in partnerships that promote learning. I give three examples. The first is a professional community in math; the second is an effort to link practice and research; and the third is an online context for community development.

The Math Forum is an online community of teachers, students, researchers, parents, educators, and citizens at all levels who have an interest in math and math education. It began as The Geometry Forum sponsored by an NSF grant to Swarthmore College. Over the years it has expanded to included math topics for elementary, secondary, and university, and graduate students and teachers. The Student Center includes the award winning Ask Dr. Math, the problem of the week and resources arranged by age from primary to graduate level math. The Teachers Place, designed by and for teachers, lists pertinent discussion groups, articles, and professional organizations. The Research Division includes conferences resources and newsgroups and mailing lists where math researchers share problems and discuss current issues. A final center is for parents and concerned citizens who might have other reasons to know more about teaching, learning, or understanding math. ÊThis online community, particularly the Teacher2Teacher service, is a good example of how the Internet is helping to organize professional communities of practice within a discipline.

Knowledge Loom is an example of a learning community that is working to develop teaching expertise. Developed by The Northeast Islands Regional Educational Laboratory at Brown University with funding from the U.S. Department of Education, the Knowledge Loom offers a rich database of school successes linked to theories of change and research evidence. Their goal is to collect fragments of teaching and learning knowledge and begin the process of weaving them into a rich tapestry of understanding of teaching and learning.



Teachers use communication tools to meet online in professional contexts as well as learn new skills. Tapped-In provides a social and professional meeting place in real (and stored) time. This place for interaction provides a 2-d world for common movement and real time dialogs with a range of tools including a virtual tape recorder to preserve group discussions, tools for taking a group on a Web tour, and white boards for saving ideas. Next to Tapped In are two other buildings in this virtual world; one is the Student Activity Center for projects; and the other is Pepperdine University where teachers can enroll in an online Master in Teaching with Technology program.

Tapped-In is one of a number of community building tools that organizations can use to build their own online communities.

The current job description of teachers does not include either the development of, or the use of community knowledge. Not all teachers have the same intellectual skills and investment in developing expertise. Those with more skill often leave teaching because there is no career ladder with different responsibilities and rewards. Professional teachers work long days. Even the best teachers cannot teach well when they teach all day. They need time to engage in challenging activities that will enrich their teaching. They need to work with adults in educational contexts that help them evolve new ways of solving new and old problems. The Future of Teaching (Riel 1996) suggests how such a system could be structured.

Conclusion

One way of understanding the usefulness of the Internet in schools is to examine the current edges of the network. What is now on the horizon, digital ink, telerobotics, virtual creatures, simulated environments, multimedia editing) will soon be classroom tools. Whatever the exact dimensions or properties of evolving new tools, it is easy to predict that they will be wireless, portable, integrated, with vast storage capacity and cheaper and more ubiquitous than the cell phones of today. The Internet will be freed from the desktop boxes. Instead information will be tied to locations using longitude, latitude and attitude. Handheld screens or projected images from glasses will be able to read bar codes now embedded information in merchandise. Information will be displayed on virtual signposts, talking objects and 3-d animations that might guide us through a museum or help keep a team of students connected. Digital Ink will make it possible for books to be printed, unprinted and reprinted at will. Given these possible developments, we need programs and policies that will assure that educational applications continue to be designed to support teaching and learning. This takes a greater "intellectual" investment in schools by a larger part of the community.

Citizenship Service to Education

This is an idea for dramatically increasing the size of the learning community available for classroom learning. As an extension to the many tele-mentoring projects, an agency like the Department of Education could manage a national "education service" similar to jury duty. Citizens could be contacted to "serve" as online learning consultants to students and teachers across the country. Individuals would be expected to go through a brief online training program (similar to the direction provided by a judge to a jury). Once completed, they will be listed in a national database available to schools. An individual might serve for different periods of time based on many different factors. All citizens are historical informants for the periods and places they lived. Most will have particular information about a job or career, and many will have other areas of strong interest that they could share. As intergenerational projects find, personal histories can transform personal memories into community treasures.

National Cabinet of Collected Thinking

All nationally funded research projects could, as a condition of the funding, be required to spend some of the resources to make an intellectual contribution to schools. This contribution might be:

- Archives of digital images or videos
- Designs for collaborative projects
- Development of a question/answer resource for teachers or students
- Interactive simulations to explore concepts or processes
- National databases that can be used by students and teachers
- Digital toolkits for visualizing data
- Remote access to tools for investigations (microscopes, telescopes, radars, etc.)
- Observations of actions, reactions, or relationships with netcams or videos
- Team-teaching using video conferencing tools

This process would foster interdisciplinary collaboration and uses of cross-disciplinary datasets, Technology tools can help students visualize difficult to understand concepts and processes such as changes in wind speed and pressure, or interactions of molecules. Teachers could join the research teams to help oversee the development of these resources. This work could help transform teaching contracts to 12 months with active work on research in disciplines. This reading and writing would help teachers continue to develop their knowledge. Their participation in partnerships beyond the classroom will help them understand how learning communities can be used for student learning. These intellectual products would then become the heart of "public" education. This would help develop the community of teachers and learners that would continually renew public education.

Video Archives of Teaching Wisdom

Now is the time to capture the wisdom of our best teachers so that we preserve what teachers have learned over decades of practice. Print publications are not the best tools for capturing teaching knowledge. Computers with enough memory and storage capacity are now within the reach of schools. The cost of digital cameras is rapidly dropping. Regional Technology Centers and university-school partnerships have begun the process of documenting good teaching, but these efforts are limited to only a few exceptional examples. Every school could be producing their teaching archives.

Schools of education could provide leadership in developing a national treasure of teaching knowledge by forming teams of expert teachers, novice teachers, university teachers and researchers, and discipline experts with the task of creating documentaries of how to teach specific content. Master teachers bring years of experience and teaching materials. Novice teachers bring enthusiasm and time, the technology resources of the university and the time to learn new skills. University professors bring theoretical frameworks and technology resources, and researchers and discipline experts widen the context with information from other studies and fields. The shared task would be to create a documentary through video clips, resources and materials on how to teach a particular subject to a group of students.

These documentaries could be used to form a national database of teaching wisdom. They would help make teaching more public. When teachers see what takes place in other classrooms, they can compare and contrast it to their own approaches. When students see what happens in other classrooms, they can better understand the different roles of learners. Analysis of video at the university allows for rich grounded discussion of teaching and educational theory. Teachers could look for new ideas by watching how teaching in different regions with different resources and students organize their lessons. Members of the community could see how their school environment and resources compare to those of students in other regions. These could become the basis of research partnerships; through collaborative analysis best practices could evolve into national standards rather than having these imposed on teachers.

Support for Educational Research Tied to Development

We need a closer relationship between teaching, research and development. The current separation evolved from past political and economic constraints on the structure of schooling. The development of communication tools and computer software makes new forms of partnership possible. Teachers can be researchers, researchers can be designers, and designers can be teachers. A community approach with differential skills produces a synergistic outcome. This shift requires a reorganization of teaching to enable teachers to work on teams. Teachers do not need to teach all day. In fact, they would be more powerful teachers if their teaching time was not so concentrated. Researchers need to work in schools to understand that decontextual randomization and control of variables often strip away the very processes that need to be studied. Working with natural variation and "design experiments" can provide rich understanding of the complex issues that affect learning. Publishing should not be the end result of research. Researchers should not leave others to implement their findings. Instead researchers should be involved in experimenting with designs for implementing findings. Teachers can serve as valued partners in helping to understand the dimensions of learning and teaching (Stigler and Hiebert, 1999). This is, in short, a call for collaborative learning, teaching, research and development.

Links

1 John Dewey [http://www.pragmatism.org/genealogy/dewey/dewey.htm] in particular see Democracy and Education (1916) published online at [http://www.ilt.columbia.edu/projects/digitexts/dewey/d_e/contents.html].

2 George Herbert Mead [http://www.utm.edu/research/iep/m/mead.htm]

3 Edward Thorndike [http://www.britannica.com/seo/e/edward-lee-thorndike/]

4 B. F. Skinner [http://www.bfskinner.org/index.asp]

5 Jean Piaget [http://www.piaget.org/]

6 Howard Gardner [http://www.newhorizons.org/trm_gardner.html] and for his theory on multiple intelligences, [http://ericae.net/digests/tm9601.htm].

7 How People Learn: Brain, Mind, Experience and School, Bransford, J. Brown, A., & Cocking,R. (Eds.) National Research Council,(NRC) The book is available online at [http://www.nap.edu/books/0309070368/html/].

8 Kristi Rennebohm-Franz's first grade classroom website is found at [http://www.psd267.wednet.edu/%7Ekfranz/index.htm] with links to the pond study is [http://www.psd267.wednet.edu/%7Ekfranz/Science/WaterHabitat/waterhabitat.htm#intoductionscience/Water habitat/wat].

9 Barry Kramer's fourth grade web site can be found at [http://www.csnet.net/coalition/fourthgrade/Fourth.Grade.html] It is likely to change each year but will have links to many current and new projects of his students.

10 IEARN International Education and Resource Network [http://www.iearn.org].

11 ThinkQuest Internet Challenge [http://www.thinkquest.org/tqic/] and the ThinkQuest library [http://www.thinkquest.org/library/].

12 Generation Why materials and information [http://207.225.234.197/genwwwy/].

13 The links for these three projects are The Holocast: A Tragic Legacy [http://library.thinkquest.org/12663/], What do you do in the War Grandma [http://www.stg.brown.edu/projects/WWII_Women/], and 1968 the Whole World Watching [http://www.stg.brown.edu/projects/1968/.org/12663/].

14 ERIC,[http://www.accesseric.org/] the Academic Guide to the Internet
[http://www.aldea.com/guides/ag/attframes2.html]
the Annenberg/CPB Projects Exhibits, [http://www.learner.org/exhibits/], The
Math Forum, [http://forum.swarthmore.edu/]
Marco Polo [http://marcopolo.worldcom.com/]and the
United Nations CyberschoolBus [http://www.un.org/Pubs/CyberSchoolBus/].

15 The Center for Biological Timing, [http://www.cbt.virginia.edu/Olh/exp.html].
The BirdHouse network [http://birds.cornell.edu/birdhouse/nestboxcam/]

16 The Learn and Live Digital Toolkit [http://glef.org/llfeatures.html] has a number of segments on learning with technology but the one referred to in this paper is the first one listed as Project based learning at Clear View.

17 Passport to Knowledge, Live from the Hubble Telescope [http://passporttoknowledge.com/hst/].

18 For more information about these educational opportunities see [http://www.gse.uci.edu/tlc/students.html#partners] and for information on these and other elelctronic field trips offered through the web see [http://www.gse.uci.edu/tlc/students.html#field].and

19 This is a link to one of the schools that worked with the team on the Virtual Canyon Project [http://www.alianza.santacruz.k12.ca.us/vcintro2.html]

20 For more information on shared virtual spaces for learning see [http://www.vlearn3d.org/]

21 for virtual universities projects, see [http://www.cruzio.com/%7Edevarco/av98edu.htm], and for the Virtual high school projects see [http://vhs.ucsc.edu/vhs/storyboard.htm].

22 California Learning Interchange [http://www.gse.uci.edu/cli/] has a number of video lessons including the one referred to in this paper [http://www.gse.uci.edu/cli/vcmath1unit01.html].

23 The Fulton and Riel (1999) paper has a very long web address but can be found easily by typing the author's names in the search function of the George Lucas Education Foundation site [http://glef.org/] or by downloading the Spring 1999: Teachers as Learners Edutopia Newsletter [http://glef.org/backissues.html].

24 The International Education and Resource Network (IEARN) [http://www.iearn.org]

25 the Global School Net (GSN) [http://www.gsn.org/]

26 Mentoring projects [http://www.gse.uci.edu/ccre/telelearning/tmentor.html].

27 Coalition of Essential Schools and the Annenberg Institute for School Reform

describe their use of digital portfolios for students [http://www.essentialschools.org/pubs/exhib_schdes/dp/dpframe.htm]. From Australia, this description includes some international examples including one from The Netherlands [http://portfolioinfo.efa.nl/uk/index.html] Many great examples of teacher portfolios can be found at [hale.pepperdine.edu].

28 U.S. Department of Education: Secretary's Conference on Educational Technology September, 2000 listing of research tools: [http://www.ed.gov/Technology/techconf/2000/tools.html].

29 Latent Semantic Analysis (LSA)[http://lsa.colorado.edu/] and Knowledge Analysis Technologies [http://128.138.93.41/] are exploring ways of using computers to assess student writing.

30 Teaching, Learning and Computing, 1998, [http://www.crito.uci.edu/tlc/html/tlc_home.html].

31 The Math Forum [http://forum.swarthmore.edu/]

32 The Knowledge Loom [http://knowledgeloom.org/index.shtml].

33 Tapped In [http://www.tappedin.org/].

34 For a description of a number of different community building tools see [http://www.gse.uci.edu/tlc/tools.html#community].

35. For a more extended discussion of the edges of the network, see [http://www.gse.uci.edu/mriel/webtour2/2/]

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Riel, M. (1995). The future of teaching. In Education and Technology: Future Visions, U.S. Congress, Office of Technology (Eds.) OTA-BP-EHR-169 Washington, D.C. Printing Office. Can be downloaded from the web at [http://www.gse.uci.edu/mriel/mrielFuture-teaching.PDF]

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Stigler, W. and Hiebert, J. (1999) The Teaching Gap: Best Ideas from the World's Teachers for Improving Education in the Classroom. Free Press. [http://www.lessonlab.com/teaching-gap/].

Note: This paper was designed to be read online. All references are linked to sources which provide additional information, which are missing in this print version. If you are reading a print copy, this paper is part of a collection of "White Papers" created for the

US Department of Education: Secretary's Conference on Educational Technology September, 2000

(http://www.ed.gov/Technology/techconf/2000/white_papers.html)

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Hi, Welcome to my online office! Feel free to look around.

My course on School Reform is currently linked with the development of the School Renewal WebCenter. If you are interested in seeing what I have done, please feel free to look around and offer comments.

I recently finished a White Paper for the U. S. Department of Education Secretary's Conference on Educational Technology, 2000 (Sep. 11-12) called New Designs for Connected Teaching and Learning. I used a shorter version of this paper as my e-testimony to the Web-based Education Commission established by the U. S. Congress to develop specific policy recommendations geared toward maximizing the educational promise of the Internet.

My AERA-2000 paper with Hank Becker. The Beliefs, Practices, and Computer Use of Teacher Leaders is now online in pdf and html format. I have short version of the paper that I would be happy to send by email.

I found a link to OTA publications so papers that were part of their Future Visions publication can be printed (or read with free Acrobat Reader). In The Future of Teaching (1995) I attempted to write about teaching and learing in 2005. A brief summary of these ideas for reorganizing teaching and learning can be found in my MCTN viewpoint article.

I am working on a school renewal web site and planning an open house in Jan, 2001. I will post when it is finished. Its is a revision of the school reform site that is currently posted at CCRE. You are welcome to drop in and offer suggestions!

Send me a note if you want to meet online. -- Margaret

September, 2000

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Some Background Information...

My education took place at UC, my B.A at the University of California, San Diego, my M.A. at the University of Chicago, and my Ph.D at the University of California, Irvine. I began my career as a researcher studying interactive learning environments at UC, San Diego. My focus then and now has been on collaborative learning, facilitated, but not controlled by technology. I have researched and developed models of network learning specifically "cross-classroom collaboration" and "electronic travel" designs.

Building on an early research project in global networking, called the InterCultural Learning Network, I designed a networking program for elementary and secondary schools called "Learning Circles." Learning Circles are a structured form of global cross-classroom collaboration in small groups now sponsored by the International Education And Resource Network (I*EARN).

I was also involved in the initial design and evaluation of the PASSPORT TO KNOWLEDGE project which uses a combination of live television, electronic networking of scientists to students, online resources and in-class materials to involve students in the collaborative process of scientific discovery.

Currently, I am a member of the faculty in the Education Department at the University of California, Irvine and serve as the Associate Director of the Center for Collaborative Education (CCRE). My research involves work with two elementary school in Anaheim to help integrate technology with instruction. I am also a member of a team of researchers lead by Hank Becker and Ron Anderson analyzing survey responses of 4,000 teachers in a National Survey of Teachers: Teaching, Learning, and Computing, 1998.

My son Michael, now studying at UCLA and my daughter Megan, a high school student, have always been the heart of my work.

For Descartes, thinking signaled existence, but in a interactive networld, it is the act of writing that creates identity...

I have written a number of journal articles and book chapters on research in interactive technology.I have included a complete list of my print publications online. The abstracts of some of these are online.

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I have recently been enjoying the use of color and graphics in a hybred from of writing and talking that I am not sure what to call, but they are much different than print publications and designed to be read on the web. The task of keeping all of them current as the web changes is difficult but I do try to keep them updated. As they are published on different servers, this requires some coordination. The web links are illustrations, the conceptual points are independent of the examples. I have listed the date they were created, even if they have been updated more recently.

Web.docs

Mind
Travels

Web Writing is form of publication that is halfway between a written publication and an oral presentation. I don't think it makes sense to call online publishing "papers," and since these presentations encourage exploration of the net world, we need a new term to talk about linked or connected writing. I am using web.docs to describe them. The number list are extensively linked with the Internet while the second set are more topically oriented. I am enjoying the use of color, imges and layout as well as the whole learning process of communicating ideas in this new medium.

1: TRANSPORTATION FOR THE MIND 1997 written as a web.doc for new teachers who were exploring the Internet as part of the AT&T Learning Network.

2: LEARNING SPACES IN NETWORLDS OF TOMORROW 1997 An extension of transportation for the mind which has been the basis for many presentations and keynotes.

3: EDUCATION REFORM AND TECHNOLOGY 1997 This guide was initially part of a course at UCI and then was published on the Well-Connected Teacher.

4: TELEMENTORING 1997 A web.doc on resources in telementoring

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created for workshops for use in workshops and presentations.

5: NEXT DOOR TO EVERYONE -- THE GLOBAL NEIGHBORHOOD
1998 Created for Harvard Institute on Leadership and New Technologies, July, 19, 1998 after a presentation to Havard's Internet and Society Conference.

6: TECHNOLOGY IS SHARED MINDS MADE VISIBLE, 1999 An annotated powerpoint presentation of my keynote address to National Education Computer Conference.

7: TECHNOLOGY LEARNING COMMUNITY'S INTERNET GUIDE
2000, A revised version of transportion for the mind tailored to learning community approaches for elementary school teachers.

8: NEW DESIGNS IN CONNECTED TEACHING AND LEARNING,
2000 White Paper/Web.doc written for the U.S Department of Education Secretary's Conference on Educational Technology. September 11-12, 2000.

Other publications written for the web (web.docs) include:

(For a listing of papers available online, please see my vita)

Riel. M. & Becker, H. (2000). The Beliefs, Practices, and Computer Use of Teacher Leaders AERA presentation,New Orleans, April. Available online at CRITO which contains other publications from the research team.

Becker, H. & Riel, M.(1999). Teacher Professionalism, School Work Culture and the Emergence of Constructivist-Compatible Pedagogies. AERA presentation, Montreal, Canada, April. Available online at CRITO which contains other publications from the research team.

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Riel, M.(1996), Internet & the Humanities: The Human Side of Networking

Included as a set of White Papers by the Department of Education.

Curriculum Guides

Learning Circles Guide Overview

Riel, Learning Circle Teacher Guide

Riel and others, Live from Antarctica Teacher's Guide

Presentations recorded online

Teaching and Learning in the Communities of the Future: The Power to Connect and Create, (Slides and Notes)Harvard Institute on Leadership and New Technologies, July, 19, 1998 and Next Door to Everyone, the Global Neighborhood, (webtour) July 21, 1998

Education Panel: Next Door to Everyone (audio) (moderated by Martha Stone Wiske and with Ron Bailey and Bruce Droste and an Interview on the issue of equity and technology, [text] Harvard's Second Internet and the Society Conference, May, 1998.

Improving America's Schools Education Reform Institute.
Using Technology as a Tool for Educational Reform.
(webcast) U. S. Department of Education, October 17, 1997

Harvard's Internet and the Society Conference, May, 1996
Education Panel: The Internet in the Classroom (text).

DEPARTMENT OF EDUCATION
UNITED STATES OF AMERICA

The Secretary's Conference on Educational Technology 2000

A Lesson from Richard Nixon: Observations about technology policy and practice in education

By
Saul Rockman

August, 2000

Where I'm starting . . .

Computers are a fact of life. Technology has become an increasingly important component of our lives, whether we planned on it or not. Microprocessors are in our refrigerators and in our cars; they entertain us and help us purchase the goods we need; they will create our medicines and deliver them to us. More than half of US households are on the Internet. Most families with children in school have a computer and practically all schools are connected to the Internet, even though inequities in both access and use abound both at home and in school.

Now, I am a user of technology—as are all likely to be reading this—and a researcher who studies the use and impact of technology in schools. I have a critic's scorn for unbridled enthusiasm as well as an advocate's defensiveness for unwarranted faultfinding. I am an affectionate cynic. I value what technology can help us accomplish, I want us to be sensible about how we use it, and I worry about the changes it is bringing to our lives.

Many of my friends and professional colleagues hold computers in businesses, in schools, and in homes to be an opportunity for changing the world beyond anything before in recorded history. It is fire; it is the wheel; it is movable type; it is the light bulb. But let us put it in perspective. It is one of many influences on our lives, one that will change us in ways we do not know, but one that is not changing all of us in the same way or at the same time.

Just how important is technology in school right now? I don't think it is as important as roofs that don't leak and functioning bathrooms that are clean and safe. I'd like all students to read—and the younger ones to be read to. I want children to come to school well-fed, healthy and happy, and enthusiastic about learning. I want them to have bright, well-prepared teachers who care about them and who have high expectations for the success of each child. There may be a few other things, but clearly, for me, there are important aspects of schooling that come before using computers.

Now don't get me wrong; I appreciate the value of technology for many things; I see its value for schooling (and learning). I use it and would have great difficulty giving up my computer. I find it sexy and sensual, powerful and empowering, both increasing my efficiency and filling my free time (sometimes wasting my free time). I want young people to have computers and to use them for important things and for pleasure. But we, as the adults, as the educators and technology leaders, must help form the beliefs and values that lead to appropriate technology access and use.

I'm certain I'm not alone in wanting these things for our schools and those who work in them (both students and adults). But many of us are struggling with issues about technology in school. Both advocates and critics are prone to accepting a series of fallacies in our policies and our beliefs about technology and education. I want to add my perspective to the discussion, for you see, I have been conducting research on school reform and technology for quite a few years, and I have an idea of how technology gets used (or not) in schools of all kinds. I also have an idea of how policy helps or hinders effective applications of technology, and how our beliefs and expectations influence the public discussions of technology in education. I have information that can temper the enthusiasm of the advocate and that can counter the concerns of the nay-sayers.

The context for my concerns . . .

This past spring, I had the privilege of participating in a series of meetings in which state delegations focused on technology and discussed ways to collect and use information for decision making. Most delegations included state technology staff, a state curriculum person, and selected district and school site leaders, often a member of a state or local school board and a teacher or two. These groups began the process of developing strategies for aggregating (and disaggregating) information about technology's use and impact in schools, and of exploring ways to use technology to analyze and disseminate information about student achievement and teacher performance. My assignment was to observe and to comment about what I saw. And as that great commentator on the human condition, Yogi Berra, once noted, "sometimes you can observe a lot by watching."

Among the earliest things I noticed, varying in degree, of course, from state to state, was the long-standing lack of communication and lack of collaboration among the technology advocates at the state, district and school-site levels. District and school-site people were surprised to learn why certain state decisions were made, and state folk were amazed at how local goals differed from place to place—and from the goals set by the state. These regional meetings, involving practically all states, appeared to be the first opportunity for practitioners, policy makers, and policy implementers to sit at the same table and work together on common issues.

Many states use the leverage of matching technology funds to encourage certain applications of technology and discourage others. Today's environment of regularly-revised subject-matter standards and frequently-revised high-stakes testing often dictates the kinds of technology training that teachers receive, the curriculum that is used, and often the pedagogy that is applied in the classroom. But even in this environment of top-down mandates and strategies, it is troubling how little opportunity there is—regardless of interest—in bottom-up feedback, in tapping into local interests to help define policy and planning. Many state-level bureaucrats (used in the nicest sense of the word) did ask about what schools are doing in response to the state's initiatives; frequently states required formal reports on how technology funds were spent. But rarely, at this gathering of state and local leaders, did I hear about a state initiative that was based on the stated needs of the districts and schools.

There appeared to be a policy disconnect between those who fund technology and establish rules and regulations for its use, and those who actually work in the districts and schools and classrooms. While state needs assessments may inform policy makers about the desirability of telecommunications networks or additional computers, these state surveys rarely engage classroom concerns for professional development in new approaches to pedagogy or for software applications that would match learner deficiencies. Evidence of the one-way, top-down relationship surfaced during the sessions, often associated with how state administrators perceived political necessity and policy demands.

Among other issues I observed were the differences in perception among people with different professional roles. These became evident in breakout sessions where job-alike groups, rather than state delegations, met to talk about the use of technology and the needs of their constituencies.

In groups focused on students, groups that included many teachers, teacher-leaders, and teachers-turned-technology coordinators, the discussions focused on improving thinking skills, on authentic learning, on collaboration, and on constructivist issues. The participants were clear about the need to use the technology assets they had, and those they hope to gain, to help students become independent learners, good problem solvers, and active participants in the new economy. There was a strong, persistent, and common belief that technology existed in the schools to help students learn how to learn and how to creatively apply what they learn in real-world settings. When the talk turned to assessing what students learned, standardized tests were acknowledged and then quickly rejected because they were either not informative for the classroom or because they were inappropriate measures of what the participants saw as the proper application of technology with students.

In other breakout meetings, attended by representatives of teacher training institutions, principals, district technology and curriculum coordinators, and staff development leaders, the discussions covered different issues, such as the preparation of new teachers to use technology effectively for instruction, professional development for the existing teaching staff, alignment of curriculum with state assessments and technology applications, and the desirability of building and district-level support for the use of computers with students. I don't recall a lot of deliberation about constructivism, about thinking skills and problem solving, or about independent learning (even on the part of classroom teachers). The participants talked about the problems they saw in setting standards for teachers' knowledge and application of technology in classrooms, in obtaining additional funding for pre-service and in-service education, and in developing a technology-friendly environment in schools and in district offices. Assessment strategies dealt with teacher performance, in demonstrations, portfolios, and reviews of lesson plans. Perhaps one or two participants mentioned student performance as an indicator of teacher performance, but more often educators reflected on the importance of not measuring teachers by the standardized test scores of their students.

At another breakout session, attended mainly by state-level administrators and policy-types, school board members and decision-makers, the discussions were different. At these sessions, the issues were about state assessment tests, resource inventories, and curriculum alignment with state tests. There was a clear focus on obtaining data that would provide supporting evidence for the state's expenditure of funds for technology. These participants were looking for ways to collect information that showed how technology made a difference in teaching and especially in learning. Sure, they were willing to look at case studies, at anecdotal evidence of school and student improvement, and even at technology skill development and attitudinal changes for teachers and students. But these were not seen as particularly useful or explanatory unless they were designed to expand on test score information. This group of participants wanted information that could be used to make state-level decisions, regardless of the burden this effort might pose on the districts, schools, teachers, or students. They were not concerned with test data that might help teachers better adjust their instruction to accommodate all students' needs effectively. Nor was there any well-stated belief that the tests were not appropriate measures of the impact of technology use or that technology use was not highly correlated to changes in student achievement. The state's money was spent on technology and the tests were the valued outcome measure at the state level.

To the observer—me—what was so interesting was the way that each group focused on its topic without concern for topics on which the other groups were meeting in adjacent rooms. Sure, they were directed by their facilitator to focus on their theme, but somehow their topic didn't intersect with other topics. There was a detachment that paralleled the disconnect between the various levels of operations, from the school to the district to the state. Were people not talking with one another? Or were they not listening? Or were people not saying what they knew to be either the truth or holding back on what the other party didn't want to hear?

Richard Nixon is purported to have stated in a meeting in 1970 that "Honesty may not be the best policy, but it is worth trying once in a while." I wonder if we are being honest with one another about technology and its use and impact in schools. Are we telling the truth about what we actually do with technology? Are we being honest with our colleagues, especially legislators and policy makers, who may have different agendas? Are we, the educators, able to fairly portray what we are using technology to accomplish in our classrooms? Are we, the educators, able to accept—or counter—what the politicians and policy makers *think* we are using technology to accomplish? And why do we continue to cling to our beliefs when we know that we will be judged on criteria that we do not control?

I'd like to talk honestly for a while, about what I believe is our lack of total honesty in communicating about technology in schools. I want to focus on a series of assumptions we have encouraged policy makers to believe, or passively let them accept about the use of technology for teaching and learning. We, the educators and technology enthusiasts, have not always told the truth, often, I believe, because we thought a little white lie would serve us better. Honesty may not always be the best policy, but shouldn't we try it once in a while?

Assumption 1: Access equals use.

Just because technologies of various kinds are present in schools, does not mean that students actually can and do use them. Mere presence is not sufficient. We have wired practically all the schools (or at least pulled a wire into the school) and many of the classrooms, but there are not always computers and routers at the end of the wire. We have taken the horse to water (or brought the water to the horse), but without equipment, training, and purpose, there is little for which the schools can use these technologies. This is not to say that Universal Service and the e-rate haven't been valuable; they certainly have made the issues visible and public, they have enlisted politicians in the cause, and they have provided the opportunity to get more technology into the schools. It's just that they haven't created the outcomes we wanted—and *they* expected—to see. But these federal programs were not designed to do it all, regardless of what these policy makers believed.

We know that most schools, even the poorest, have access to the Internet; we also know that the poorest schools do not have the same access in their classrooms as the richer schools. (About half as many classrooms have Internet access in schools with the poorest students when compared to schools with the richest students.) We know that inner city schools have less access to both computers and the Internet, and that poor students average 16 children per computer in contrast to the 7-to-1 or better ratio in schools with wealthier kids. But access isn't important if no one uses the computers that are available.

There is a mistaken belief among many federal and state legislators, school board members and district administrators that, by providing access, the job is done. We have tried, with only modest success, to dissuade them from this conclusion, but we haven't succeeded. If schools have access to the Internet and there are computers in reasonable numbers, we also need to know that the teachers are prepared, that the technology is maintained and in working order, and that appropriate software is available. Further, we must also have a culture that encourages and supports the use of technology for teaching and learning.

Without well-prepared teachers, whatever technology is available will not be used or may not be used to reach appropriate outcomes. Computers aren't the answer for everything, nor are the options they provide an opportunity to be ignored. We need to have professional training and models for use, or teachers will continue to do what they have done in the past. Without well-maintained computers, teachers will lose interest and even begin to reject technology as part of the arsenal of teaching tools. We all believe that computers are "mission-critical" for businesses, and if a machine breaks down, it needs to be repaired immediately. Not so in education, and when teachers wait weeks or months for a repair to be done and redesign lessons as a result, they may not be encouraged to continue using technology in the classroom. And "Why bother" is not an unreasonable response.

[One could even make the argument that providing telecommunications access and truckloads of computers is not even the start of a solution for many urban and rural schools whose 70 or 80 year-old buildings do not have sufficient electrical outlets and power to safely permit the technology to be plugged in. Aging infrastructure is an impediment to universal access for many schools and keeps large numbers of students from using technology that students in neighboring schools can.]

The same is true for software and resources that facilitate teaching and learning. Without the tools to accomplish the tasks of schooling, the presence of working computers is not satisfactory. Teachers and students need the software that permits them to accomplish the tasks they have identified as important; they need reasonable access to the Internet, and they may also need other technologies, such as science probes, videos, and video production equipment. And most certainly, without the active support of the principal, and in turn the support of the district administrators, using technology in the classroom is not going to be a desirable or even a sanctioned classroom activity.

We need to start telling, or more forcefully persuading, those who legislate and fund and set policy that access is not a sufficient response, and that placing a wire and a few computers in each room will not ensure that students and teachers use the technology in productive ways. We need to thank them for the good start, but insist that their responsibility doesn't end with access. Schools need to be retrofitted for technology; we need to budget for repair staff and maintenance facilities, we need materials budgets that make it possible to acquire legal copies of software for students and teachers. And we need the legitimization that comes not from words, but from deeds.

Assumption 2: That technology is actually used in school in substantive ways.

I think we are all familiar with schools where computing is not widely available, where the technology is old and in disrepair. I think we know about schools where there might be one or two computers in a classroom that students can use when they complete their worksheets, and a lab where students get about one-to-two hours of computer access a week, on the average. We also know classrooms where students operate with little supervision and surf the Internet to explore the websites of their favorite sports team, the WWF, or Britney Spears.

I have a sense of what it is like at the other extreme, where computing is ubiquitous and all children have a laptop computer for home and school use. We have been studying students with above-average access to computers in school (and universal access at home) and comparison classrooms of students who had access all the time, with a laptop of their own. We shadowed them for days, noting what they did and when they did it; we asked others to keep logs of when and for how long they used computers. We found that seventh graders with full-time access used computers as much in a day as non-laptop students used them in a week. Tenth graders with laptops used computers in school more than two hours per day, over nine times as much as non-laptop students. Most importantly, this use of their computer was for the work they were accomplishing in school, not for games and chats and surfing entertainment sites on the Internet.

So what do we mean when we say that computers are used in schools? Does an hour or so of use each week mean that students have an opportunity to use technology for meaningful work? Or is it a modest intervention, that is more of a chance for them to master computer skills and write an essay now and then? Is fifteen minutes on a drill-and-practice program three times a week sufficient to make a difference in standardized test scores? And with little opportunity to use technology when they want to—as the needs arise or the desires materialize—just how useful is the computer to the students' academic life?

When students have access all the time, they have the choice of bringing their laptop out to take notes, collaborating on projects, writing their essays when the opportunities arise. We found that students with fulltime access to laptop computers used them for a variety of tasks and in all subject areas; they use them for writing and research, for taking notes and for organizing and analyzing data. They used computers in the same fashion that we, as adults, use them, as tools to accomplish their work, in this case, the work of school.

Given what we understand about what gets accomplished in schools where students have ubiquitous access, it becomes harder to say that students in classrooms with limited access have the opportunity to use computers in powerful ways. Yet, we have been telling administrators and policy makers that we are doing important things with technology, so important that they will influence student achievement in measurable ways. We need to provide them with information about what we actually do, admit our limitations, and argue not that we're accomplishing the important goals of education using technology, but rather that we're doing the best we can with the limited resources we have. We should be holding up professional models of access and use, rather than claiming to be second class citizens with only a limited need to have technology where we need it and when we need it. I don't think it's whining to ask for the tools to do the job we ask them to do.

Assumption 3: Teachers want to (or should) use computers to teach (but they haven't learned how).

Most teachers did not go into their profession because they wanted to manage student learning; they got in because they wanted to teach. They didn't plan on a career where they would oversee students working individually or in small groups using computers; they planned to teach. We've long acknowledged that teachers teach the way they have been taught, and since most have gone from 16 or 17 years of school right back to the classroom, in front of the room rather than in a seat, they know best only one way of teaching. The teacher stands in the front of the room dispensing information, and walks around, peering at student work, as children individually complete their worksheets or write their essays. If the computer doesn't fit into this plan, then using computers may not be teaching. So why should teachers want to use computers to teach, when *they* want to do the teaching?

Larry Cuban has been outspoken about the fact that teachers know how to use technology—to create lessons and instructional materials—but that they do not know how to use it to teach. Consequently, he says, teachers use computers at home to accomplish their work, but don't use computers in schools to teach. Teachers aren't technophobes, he states, just unfamiliar with ways to teach with computers.

Cuban's focus is on teachers, not on students; he says nothing about using technology for students to learn. Clearly, teachers can use computers to accomplish their work, but they may not let students use computers in school to accomplish the work they assign.

Cuban also complains that computers are being used for word processing and low-end applications and not the high-end multimedia applications he endorses, and his perception may accurately reflect what goes on in schools. What do kids do in school? Write essays and do work sheets. Could teachers do more and different? Yes. Could technology help? Certainly. That technology is being used to maintain existing instructional practice is the choice of teachers, not a constraint of the technology.

Changing pedagogy to use technology well requires a shift in the power balance of the classroom. It means focusing on learning, not teaching; it means providing opportunities, not information. It means teachers relinquishing control over students who have access to computers and the Internet. That is difficult in the teacher-centric world that Cuban sees—and I'm arguing that his model, not his perception of teachers and classrooms, is faulty. Learners can learn, even if teachers aren't doing traditional teaching.

It is an issue of power and control. We ask that all practicing teachers master technology and apply it in the classroom, and that all pre-service teachers learn it, too. Most professionals learn enough about computers to get their work done, but they don't need to learn more than that. For example, physicians may master a piece of extraordinarily complex software needed for the diagnosis of disease, but not know how to access the Internet. Teachers don't need to master all the software tools to get the best from their students, yet we insist they learn them. I'd rather teachers learn to say "yes" when students want to try out a new tool and then share what they learn with their peers. Too often we hear, "No, you can't use that because I don't know how to use it, yet." I think students, if given permission, could master and apply technology in amazing ways. When offered challenges and given powerful technology tools, our students can do marvelous things. But how do we get educators to give permission and get out of their way?

We need to free our children from the constraints that teachers impose when they don't know a technology. We need to give them permission to try—and occasionally to fail—rather than preventing them from gaining access to skills and ideas and information that will help them decide what work they want to do and how they want to do it. In our study of schools and classrooms where everyone had a laptop, we found dramatic and significant amounts of role switching. Teachers became students and students became teachers, all with the goal of developing new skills and acquiring knowledge. This is what we, as educators, like to see.

School administrators often perceive and talk about technology as a tool to support and extend teaching, or even to replace teaching staff. Teachers, justifiably, are disturbed that technology is thought of as something that can replace them or alter their role as teachers; they thought their part of the system was sacrosanct and protected. We need to convert this opportunity to inform administrators and policy makers that technology is not only a teaching tool, but, more importantly, a powerful learning tool that can change classroom culture. As such it requires different ways of thinking about the classroom and its organization, about pedagogy, and about control. These are highly emotional issues for all concerned, but such is the power of the technology to support changes in teaching and learning. Before we agree to make such changes, we need to consider the implications of these changes for how we assess and define success.

Assumption 4: Computers are used in ways that can improve students' scores on standardized tests.

Legislators and policy makers and parents are looking for simple answers to complex questions. "What is the impact of technology?" they ask. "Do test scores go up?"

We rarely stop to think whether the two questions are related. Are student test scores associated with the use of technology? Is the impact of technology use something that will show up on tests? Although these are not unreasonable questions, given the costs of funding education and technology programs, they may be the wrong questions. As norm-referenced, standardized tests are increasingly applied as the primary criterion for school success and improvement, we, as educators, continue to struggle with the implications of these high-stakes assessments. I don't want to rail against testing programs in this essay, but I do want to talk about the relationship between technology in schools and expectations about testing outcomes.

For the past six or seven decades (much of it well before my time), those of us involved with the application of technology in education have been faced with the question of its impact on test scores, probably because the more enthusiastic among us promoted the technology-of-the-day as a solution to most learning deficits and teacher problems. Every new or emerging technology would provide all students with the best teachers in the nation, the most motivating conditions for learning, access to all the world's information, increased learning rates, and put fun into mastering the skills needed for career success. The phonograph, radio, television, computers, multimedia, the Internet—all were offered as *the* solution.

Well, maybe we didn't tell the whole story. While we saw the promise, we didn't realize the difficulty and high costs of getting there; and we didn't see the need for partnering with teachers and administrators to assure adoption and success. We quickly learned that it wasn't education driving the development of the new technologies, it was business and entertainment. Everyone could see how each new technology was changing the society and could imagine how it could also change schooling. So why didn't test scores go up?

Sure, we can demonstrate test-score increases with the use of full-curriculum packages that use technology to deliver instruction and practice, such as those from CCC, or Compass Learning, or Lightspan. Packages, such as these, offer different roles to teachers—as diagnosticians, as managers and motivators of learning, but not as the provider of information. These new roles, in turn, require new skills, such as interpreting printouts of student progress and assigning appropriate new materials based on those outcomes. This may, for many teachers, take the pleasure out of being a professional, but, for many students, especially those significantly behind their grade-level peers, this use of technology often leads to short-term test score increases.

As exciting as this may be for building and district administrators, packaged curriculum isn't a solution for all. It certainly doesn't delight the technologists and educators engaged in constructivist approaches who see the opportunity of new ways of learning provided with computers and telecommunications. It is expensive and narrowly focused, they say, even if it does improve test scores for some students.

What is more common in schools around the country is a more loosely-structured application of technology: writing essays and reports, putting on class presentations of projects, using educational software that covers a particular concept or reinforces a skill. An hour or two a week of computer use in school seems a modest treatment. Why would we expect this limited effort to make a difference in norm-referenced measures of achievement? We know that parents' occupation and income are the primary contributors to test score differences, but we can't easily manipulate those variables. So legislators and policy makers look at technology as a costly intervention that should offer results, just like its advocates promised.

What we use computers to accomplish in schools are things that are not normally assessed on the norm-referenced, standardized tests used nationally and/or by individual states. We are doing more writing, more problem solving, more and deeper research, more engagement with the real world and with people outside of the classroom. What many children are learning—along with facts—are strategies for learning, thinking skills, and ways of working that will stand them in good stead in the work world they will be entering. These are things that are important to success beyond school, yet they aren't being tested.

Take writing, for instance. We do have evidence that writing will improve when it is taught using the computer. (The evidence also suggests that using the computer to write without teaching writing doesn't seem to improve writing scores.) However, we don't let our students use a computer to write on tests. Most state and nationally-normed tests include a writing sample that is assessed according to a rubric. Many students have spent more time writing on a computer, with its ease of editing, than writing with pencil-and-paper. Their skills and strategies have developed with the tools they use. In settings where schools have permitted writing samples to be prepared on computer, we are learning that their scores will improve when compared to students who write in a traditional fashion. Pencil-and-paper exams may seriously underestimate the writing abilities of millions of students, especially for students with good keyboarding skills. While we still don't know enough, it may also be that scores on other elements of standardized tests may also show improvements when students are allowed to take them on the computer. But without sufficient numbers of computers in schools, and improved security systems, we're not likely to know in the immediate future.

We have to begin telling a bit more of the truth to parents, school administrators, legislators, and policy makers. We need to say publicly and frequently, "We do not usually use technology to improve test scores." While we could easily improve test scores by teaching test-taking skills using computers, I believe we would be better off to use technology to reach a little higher in the educational food chain, and work on the ways technology can extend our reach even further. We have to try a little honesty. Technology in school may best be used for the things that adults use technology to accomplish, their work. In the real world, we write, we organize and analyze information, we do research, we communicate with one another, all using technology. It is a tool for our activities. It is the activity, not the technology that will help students learn important skills and knowledge and, if tests are eventually designed to assess the important work we do, improve our test scores.

Assumption 5: Learning from (and about) technology occurs only in school.

We have reached the point where more than half of the homes in the US have a computer and access to the Internet. In homes where there are students in elementary and secondary school, more than 70% have access to the Internet. But home is not the only place where young people have access to computers and the Internet. In community technology centers, in Boys and Girls Clubs, in Y's and Girls Inc., in churches and afterschool care facilities, and in public libraries, students can find a computer and access to the Internet. Clearly there are inequities in access, mostly based on income and zip code, but these are dramatically changing as the cost of owning a computer diminishes and more local resources are established in neighborhoods where they are most needed. But the facts are evident: young people have substantial access to computers and the Internet outside of the school walls.

Thirty years ago, soon after *Sesame Street* first began broadcasting, young children started coming to school better prepared and with more knowledge than they had in the past. They knew the alphabet, numbers from 1-20, and many other things. Kindergarten teachers needed to change their curriculum to account for this new student entry level. It wasn't a panacea for all students, and the middle classes improved more than those with limited income, but the floor was raised.

We are beginning to find ourselves in the same situation today, with computers and the Internet. Students can undertake assignments at home, in the public library, or at an afterschool facility, and their reports can include information not found in their textbooks or lecture notes. They can identify experts to consult, capture and analyze data, work together with others in the same school or in other states. Yet, are our teachers and administrators willing to acknowledge this change in the out-of-school learning environment? Are they willing to accept the kinds of work-products coming from these students, and able to take advantage of the new learning opportunities at home and in the community? So far the answer is, "not especially."

I am constantly bumping into teachers who ask their students to develop and revise their essays using pencil-and-paper, and only enter them on the computer when they have been perfected. I am surprised to find those who ask their students to use only the library resources in their school to prepare reports. And I do find teachers who assume that anything coming in with an Internet reference, contains plagiarized material. I also know students who have their own websites but are still required to take a computer literacy class or told not to submit their reports as print from the computer. Large numbers of teachers and administrators are not sufficiently familiar with today's technology to know that, while they may not be part of the new age, their students are. They know what is being taught in school, not what is learned outside of it. We differentiate among students for class assignments, for reading assignments, for class selection, and for other instructional events, yet we set constraints for those who come to school knowing more than we do about technology.

What appears to be worse, at least to me, is the more difficult issue of how to take advantage of the technology and telecommunications opportunities available to our students. Generally, we don't know how to create assignments for students to do at home or at the library that could build or extend their technology skills or engage them in productive ways. These are risks that we should be willing to take, since students will be using the technology for chat rooms and games unless we present them with different challenges. We can encourage their enrollment in online courses, set them up with adult mentors in areas of strong interests, have them be tutors for younger children, or become penpals for seniors. We can build on school work or extend school through public service in the community by taking advantage of the interest, abilities, and access to computers and the Internet that students have outside of school. If we don't we're missing a great opportunity.

Is honesty the best policy?

After thinking about the assumptions we make, I'm of the belief that honest communication can prove beneficial.

Our country and our schools are in the process of flux. We find ourselves with a burgeoning school population, an enormous budget surplus, great concern about the preparation of new teachers, money being spent to improve the situation, rapidly changing but less and less expensive technologies, and assessment tests that seem to be revised every few years so that no real measures of change are possible. We can take advantage of this flux by speaking clearly about technology and education to policy makers and school administrators, and across the boundaries that differentiate among schools and districts and states.

We should be able to talk with legislators and policy makers about the status of technology in schools. We can thank them for helping education gain access to the Internet, but also remind them that access is not sufficient to reach our goals. We can reassert our need to have the tools to accomplish the job with which we are charged. We can tell them that what we use technology to accomplish may not be exactly what they think they are funding. And we can provide information about the important things we are using technology for in school administration and how the skills being developed by our students are those that our society needs and wants. We can help them see that the SCANs skills they identified eight years ago remain important components of education and also see that technology is a powerful vehicle for helping students develop the ability to collaborate, to solve problems creatively, to communicate effectively, and to apply the skills they are learning to the real world.

We can ask school administrators to create environments where technology can be used for learning, as well as for teaching, and where both learners and teachers have sufficient access to computers and telecommunications to do their work. We need to encourage the site-level leadership to help teachers accept the levels of student access outside of schools and take advantage of it. And we need building administrators to share how technology is used well: how technology can motivate those who are having a difficult time in school, how it can connect students and teachers to the real world and have them engage in meaningful problem solving, how it can improve communications skills, how it can offer more challenging work in the classroom, and how students become more responsible for their own work and their own learning. We need principals and district administrators to become a defensive line against the charge that improvements are measured only by test scores, and to mount an offense by portraying, to the press or influential community leaders, information about the important things that are being accomplished with technology, even if those things aren't improvements in test scores. (Sorry about that sports metaphor.)

We also need greater and more open communications within each state. Educators at the state level need to be brave enough to inform the legislature about how technology is being used in schools and what it is—and is not—accomplishing. We can point to changes in productivity in school administration, to more technologically-literate students who will be taking their place in our workforce, and to changes in teaching and learning that will eventually result in a more informed and capable citizenry. To accomplish this, we need more effective communication on the part of all educators. The states' education leaders need to become more aware of what teachers and students are actually doing and be responsive to their needs. Challenge the assumptions of the legislators and policy makers with evidence from the schools—not from test scores, where you're more likely to lose than win. Reflect, from the schools and the districts, on what opportunities exist for improved teaching and learning—in school and out—so that both the policies and the outcomes are more realistic.

But first, we the technology advocates in this nation's schools, must step up and offer a more realistic perspective on how we actually teach and learn using technology. And we can identify the resources and efforts needed to effectively accomplish our goals. We must stop offering a solution, when one doesn't exist; we have to recognize that technology alone won't create improved schools or improved learners. We have to continually remind ourselves and others that change doesn't happen immediately and that trivial uses of technology will not stand up to scrutiny. We must establish partnerships with those who can help accomplish our goals for learners, be they in elementary, secondary, or higher education.

As I said at the start, I am an affectionate cynic. I can see some of the mistakes and false arguments we have made. Yet, I want to see us succeed in our struggles to improve education and help students become the best life-long learners that they can. All technologies—the phonograph, radio, television, computers, the

Internet—hold out a promise for a better future, especially for our children. A little honesty in the right places can help us achieve it.

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Saul Rockman

What does Saul Rockman say about how technology prepares students for the workplace? Click here.

Saul Rockman consults on education and technology for corporations, state and federal agencies, and educational organizations. He established Rockman et al in 1990 after leaving the education marketing group of Apple Computer where he was manager of education research.

While at Apple, Rockman disseminated research findings on the impact of computers for learning and managed a large-scale effects study. He helped Apple establish partnerships with educational organizations for national technology policy development. Prior to joining Apple, Rockman was director of technology programs at the Far West Regional Educational Laboratory (now WestEd) in San Francisco, California. There he conducted research on teacher training programs in technology, analyzed technology resources in social studies, developed distance education projects for rural schools, served as executive producer of award-winning videos on child care, and conducted technology policy research. Before moving to San Francisco, Rockman was director of research at the Agency for Instructional Technology in Bloomington, Indiana. At AIT, he conducted research on numerous instructional television programs for a consortium of state and provincial educational agencies and developed and managed a computer and video project on problem solving. He was noted for creating innovative evaluation techniques for television and computer materials.

Rockman writes and speaks on the impact of technology on learning, equity issues and technology policy, children s television, and evaluation methodology. He is the producer of award-winning children s television, and designer of award-winning multimedia projects, and has consulted for diverse

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organizations ranging from the Department of Education to The Disney Channel. He has written successful Challenge Grant proposals and is holds the evaluation contract for four Challenge Grant projects. Current and recent clients of Rockman et al include: Ameritech, Apple Computer, Autodesk, Br derbund, The Buddy Project, California Department of Education, Claris, Compaq Computer, Congressional Office of Technology Assessment, Children s Television Workshop, Indiana Department of Education, Microsoft, Pacific Bell, PBS, TRO, US West, WarnerActive, and several NSF and Department of Education projects.

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The Secretary's Conference on Educational Technology 2000

It's Time to Upgrade: Tests and Administration Procedures for the New Millennium

By
Michael Russell

A Tale of a Time Past

Imagine. Virtual reality transfers us back in time. The eraser capped pencil was invented just twenty years ago. Since then, it has matured from a novelty item flashed by the wealthy to a common household tool. Students across the country are replacing their quill and inkwells with pencils. When asked why, they exclaim, "It's so much easier to write with a pencil. I can let the ideas flow from my mind to paper without constantly dipping my quill in ink, blowing dry each row of ink before moving on to the next line, or worrying about how to correct mistakes." And in classrooms, teachers observe that students write more and better with pencils than they did with the old fashion writing tool.

Yet, once a year, the state demands that students set aside their pencils and dig out their dusty ink wells and worn quills. For it is testing time and to insure standardization, all students must write with the same tool.

For students who have not yet transitioned to the pencil, test day is just like any other day, only the stakes are a little higher. For those students fortunate enough to attend schools that make pencils available to all students or who have parents that have invested in pencils for them, testing day is one filled with frustration. They have lost the art of quill dipping and have difficulty applying the proper amount of ink to their quill tips. Accustomed to recording ideas as they flow from their mind, they forget to blow dry each line of text. As the clock ticks, they find both their words on paper and thoughts in mind growing more smudged. At the end of the day, the best writers still produce good work, but few pencil users are proud of their performances. And their teachers sense that their students' essays do not reflect their true achievements.

The Story of Today

Fast forward to the new millennium. Pencils are omnipresent, but are rapidly being replaced by computers. Increasing numbers of students across the country are gaining access to this new writing tool at school and at home. Beyond increasing the fluidity with which students record their thoughts, computers help students see errors in their writing, make more revisions to their writing, produce fewer spelling errors, and develop a better sense of audience (Dauite, 1984, 1985; Wresch, 1984; Elbow, 1981; Owston & Wideman, 1997). Students who use computers regularly see measurable improvements in the quality of their writing (Cochran-Smith, Paris & Khan, 1991, Owston, Murphy & Wideman, 1992; Owston & Wideman, 1997). Yet, on test day, computers are forbidden and the performance of students accustomed to writing with computers suffers. Teachers know their students' essays do not reflect their true achievements.

And teachers are right. Recent research shows that paper and pencil tests severely underestimated the achievement of students accustomed to writing on computers.

What Research Reveals

Several studies have shown that the mode of administration, that is paper versus computer, has little impact on students' performance on multiple-choice tests (Bunderson, Inouye & Olsen, 1989; Mead & Drasgow, 1993).

More recent research, however, shows that young people who are accustomed to writing with computers perform significantly worse on open-ended (that is, not multiple choice) questions administered on paper as compared with the same questions administered via computer (Russell & Haney, 1997; Russell, 1999; Russell & Plati, 2000).

Research on this topic began with a puzzle. While evaluating the progress of student learning in the Accelerated Learning Laboratory (ALL), a high-tech school in Worcester, MA, teachers were surprised by the results from the second year of assessments. Since infusing the school with computers, the amount of writing students performed in school had increased sharply. Yet, student scores on writing tests declined significantly during the second year of the new program.

To help solve the puzzle, a randomized experiment was conducted, with one group of sixty-eight students taking math, science and language arts tests, including both multiple-choice and open-ended items, on paper, and another group of forty-six students taking the same tests on computer (but without access to word processing tools, such as spell-checking or grammar-checking). Before scoring, answers written by hand were transcribed to computer text so that raters could not distinguish them from those done on computer. There were two major findings. First, the multiple-choice test results did not differ much by mode of administration. Second, the results for the open-ended tests differed significantly by mode of administration. For the ALL School students who were accustomed to writing on the computer, responses written on computer were much better than those written by hand. This finding occurred across all three subjects tested and on both short answer and extended answer items. The effects were so large that when students wrote on paper, only 30 percent performed at a "passing" level; when they wrote on computer, 67 percent "passed" (Russell & Haney, 1997).

Two years later, a more sophisticated study was conducted, this time using open-ended items from the new Massachusetts state test (the Massachusetts Comprehensive Assessment System or MCAS) and the National Assessment of Educational Progress (NAEP) in the areas of language arts, science and math. Again, eighth grade students from two middle schools in Worcester, MA, were randomly assigned to groups. Within each subject area, each group was given the same test items, with one group answering on paper and the other on computer. In addition, data were collected on students' keyboarding speed and prior computer use. As in the first study, all answers written by hand were transcribed to computer text before scoring.

In the second study, which included about two hundred students, large differences between computer and paper-and-pencil administration were again evident on the language arts tests. For students who could keyboard moderately well (20 words per minute or more), performance on computer was much better than on paper. For these students, the difference between performance on computer and on paper was roughly a half standard deviation. According to test norms, this difference is larger than the amount students' scores typically change between grade 7 and grade 8 on standardized tests (Haney, Madaus, & Lyons, 1993, p. 234). For the MCAS, this difference in performance could easily raise students' scores from the "failing" to the "passing" level (Russell, 1999).

In the second study, however, findings were not consistent across all levels of keyboarding proficiency. As keyboarding speed decreased, the benefit of computer administration became smaller. And at very low levels of keyboarding speed, taking the test on computer diminished students' performance. Similarly, taking the math test on computer had a negative effect on students' scores. This effect, however, became less pronounced as keyboarding speed increased.

A third study, conducted during the spring of 2000, found similar effects for students in grades four, eight and ten. In addition, this most recent study also found that students accustomed to writing with eMates (portable writing devices capable of displaying about twenty lines of text) also performed significantly worse when forced to perform a state writing test on paper. Furthermore, this study found that the mode of administration effect was about 1.5 times larger for eighth grade students with special education plans for language arts than for all other eighth grade students.

The effect was so large that eliminating the mode of administration effect for all five written items on the state language arts test would have a dramatic impact on district level results. As figure 1 indicates, based on last year's (1999) MCAS results, 19% of the fourth graders classified as "Needs Improvement" would move up to the "Proficient" performance level. An additional 5% of students who were classified as "Proficient" would be deemed "Advanced." Similarly, figure 2 shows that in grade eight, four percent of students would move from the "Needs Improvement" category to the "Proficient" category and that 13% more students would be deemed "Advanced." And within one elementary school (Figure 3), the percentage of students performing at or above the "Proficient" level would nearly double from 39% to 67%.

Figure 1: Mode of Administration Effect on Grade 4 1999 MCAS Results

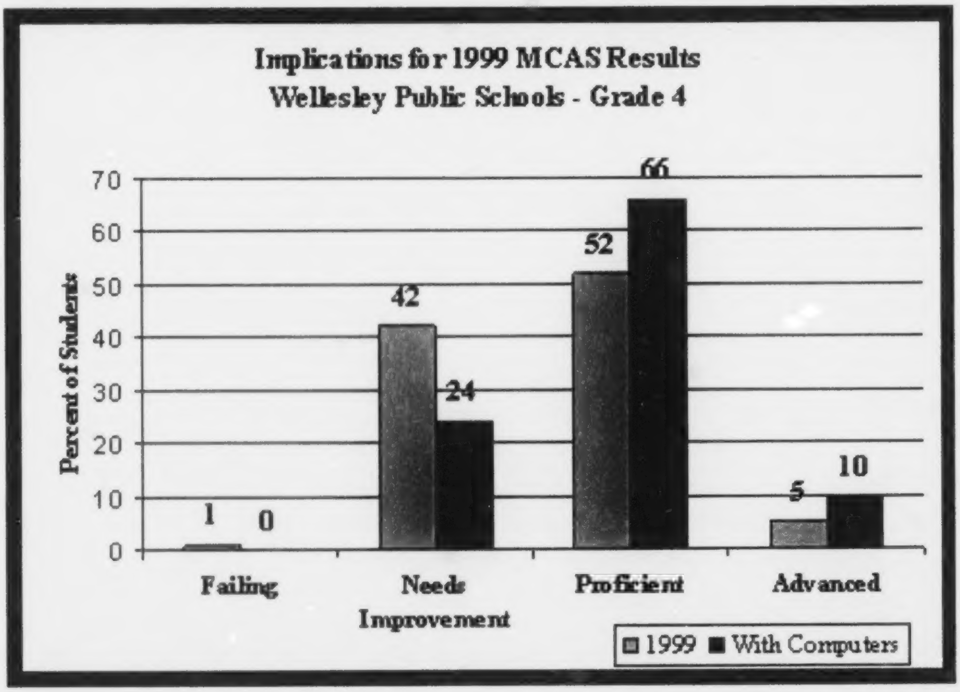


Figure 2: Mode of Administration Effect on Grade 8 1999 MCAS Results

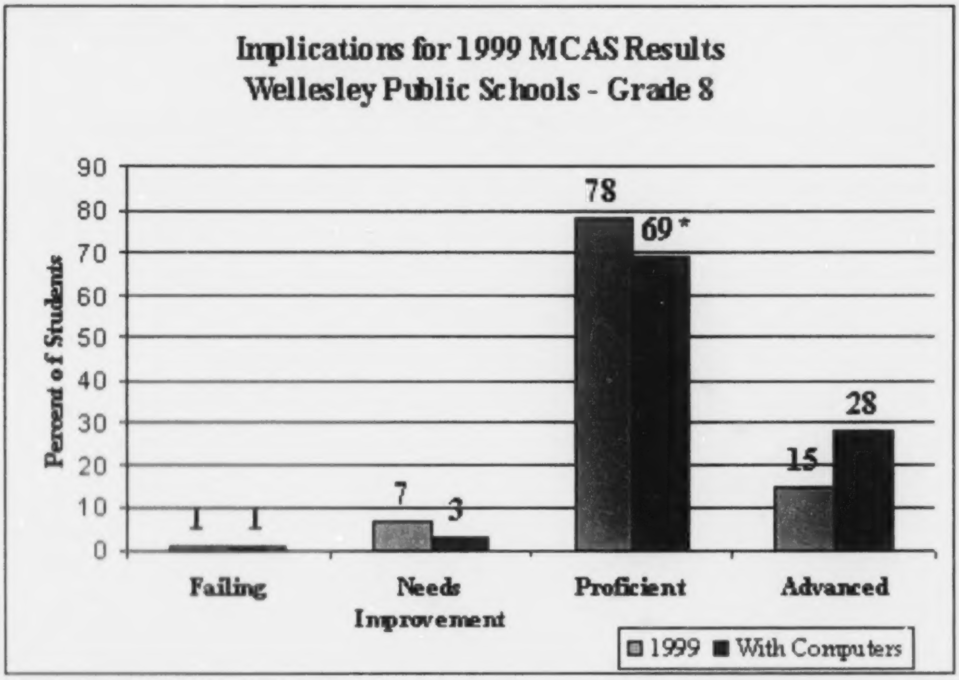
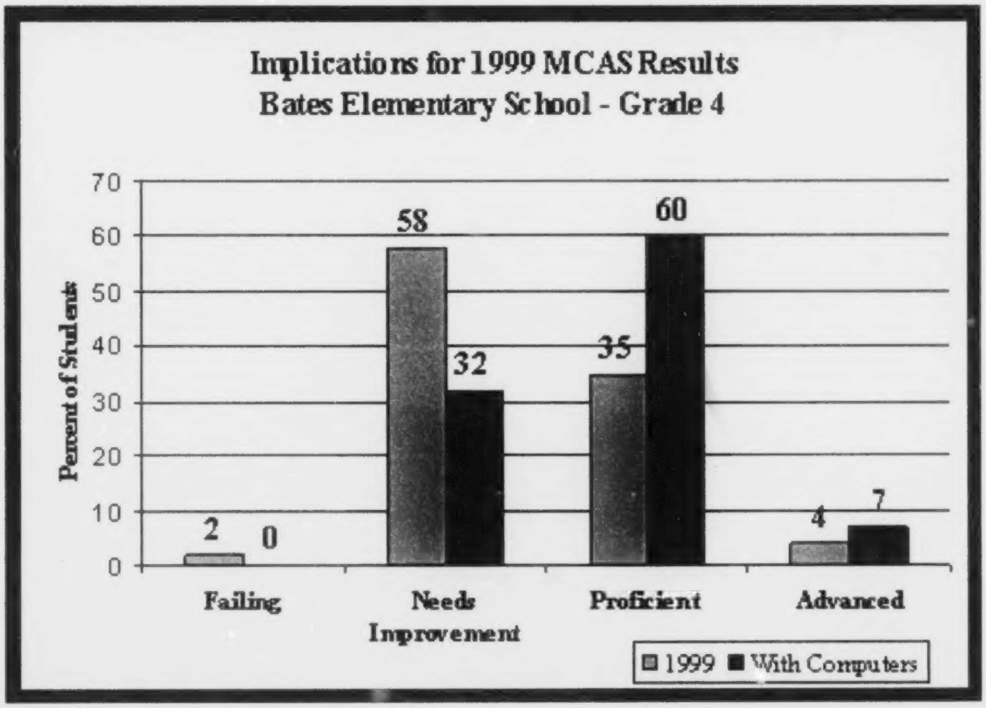


Figure 3: Mode of Administration Effect on Bates Elementary School 1999 MCAS Results



The Conflict

From my perspective, this mis-measurement of students accustomed to writing with computers is problematic for three reasons. First, several states make important high-stakes decisions about students and their schools based on these test scores. For students accustomed to writing with a computer, these decisions are based on tests that underestimate their achievement. Decisions based on these inaccurate test scores mischaracterize students and schools who have adopted computers as their tool for writing.

Second, increasingly the public and the press are pointing to stagnant test scores as an indication that investments in educational technologies are not impacting student learning. In the case of writing, the current paper-and-pencil tests underestimate the achievement of students who are using computers for writing. As a result, improvements may be masked by underestimated scores.

Third, as pressure to improve scores on state tests increases, some schools are beginning to limit computer use for writing so that students are not mis-measured by paper-and-pencil tests (see Russell, 1999). After reviewing the first study described above and following the introduction of the new paper-and-pencil MCAS test in Massachusetts, one school required students to write more on paper and less on computer (Russell, 1999). In another Massachusetts school system, the principal feared that students who wrote regularly on computer would lose penmanship skills, which might lead to lower scores on the new state test. This school increased penmanship instruction across all grades while also decreasing students' time on computers (Holmes, 1999). Such strategies, in effect reducing computer use in schools to better prepare students for low-tech tests, may be pragmatic given the high stakes attached to many state tests. But they are also short-sighted in light of students' entry after graduation into an increasingly high-tech world and workplace.

A Short-Term Solution: Provide Options

One solution state testing programs might adopt to reduce the mode of administration effect is to allow students to select the mode in which open-ended responses are composed. For the past decade, the Province of Alberta has employed this strategy for its graduation testing program. Over the past five years, the province has seen the percentage of students opting to perform the English, Social Studies, Biology, and French tests on computer increase from 6.7% in 1996 to 24.5% in 2000. Within high schools, the percentage of students opting to perform the test on a computer ranges from 0 to 80% (Sakyi, 2000).

Although this approach adds to the complexity of test administration procedures (see Russell & Haney, 2000 for a fuller review of added complexities), providing students the option of working on either paper or computer would create writing conditions that more closely reflect normal practice. In turn, students would be better able to demonstrate their best possible work under the circumstances.

To date, however, state testing programs have expressed considerable resistance to providing students the option of writing on paper or on computer. Their reasons include:

1. Concern that penmanship skills might deteriorate if students did not have to write state tests by hand.
2. Concern that computers provide students with an unfair advantage because there is something about the computer rather than the student that improves the quality of student writing.
3. Concern that students in schools that do not have large numbers of computers would not be able to take advantage of a computer option.
4. Concern that a computer option might increase scores for students in wealthier districts that invest in computers and, in turn, increase differences in the scores between urban and suburban districts.

Although I do not have room here to respond more fully to these concerns, I believe they pale in importance given the high-stakes decisions that test scores are being used to make about students, schools, and the impact of technology on student learning. As Elana Scraba (2000), the Assistant Director of Alberta's Learning Assessment Branch, reasons, "We are interested in students being able to demonstrate their best possible work under the circumstances, and have always believed that their writing tools should be compatible with how they normally write." The less performance on tests reflects what students can actually do, the less we can say about student or school achievement and the role computers play in this achievement.

Writing: The Tip of the Iceberg

When used appropriately over an extended period of time, computers can have a positive impact on students' writing skills (Cochran-Smith, Paris & Khan, 1991; Owston, Murphy & Wideman, 1992; Owston & Wideman, 1997). But writing is just one of several types of learning that computers can help students develop. Some other areas of learning include: a) problem solving; b) research; c) non-linear thinking; d) developing a better understanding of concepts related to physics, earth science, biology, and chemistry; e) collaboration; f) spatial reasoning; g) statistics; h) media; I) music theory; and J) modeling and simulating complex mathematic, social, and scientific relationships. Among all of these areas, only one is extensively measured by current state-mandated testing programs, namely writing. Yet, as summarized above, there is mounting evidence that current testing methods seem to do a better job mis-measuring than measuring the impact of computers on writing.

While I sympathize with those students and educators who believe that there are already too many tests, I also believe that new instruments are needed to more accurately measure the skills and knowledge computers help students develop. To the public, tests are seductive because they seem to provide objective, scientific measures of what students know and can do. In reality, tests are not as objective and scientific as the public believes. However, as Hawkins (1996, p. 49) wrote, tests and other methods of assessment do "provide us with the terms, images, and emotions of what it is important to know." Until tests that measure the types of learning enabled by computers are developed, it is likely that the public and policy makers will under-value the types of learning influenced by computers. In turn, the public and policy makers will continue to under-estimate the impact computers have on student learning.

Arguably, some current tests measure problem solving skills, scientific understanding, statistics and spatial relations. However, the number and types of items used to test students' achievement in these areas is insufficient for assessing the impact of computer use on these skills. As just one example, an evaluation of a Massachusetts school district recently conducted by Russell (2000) revealed that most third and fourth grade teachers in this district use computers as a part of their mathematics instruction to help students develop spatial reasoning skills. However, on the state's fourth grade test (MCAS), only two of the 39 released items relate to spatial reasoning. Thus, it would be tenuous, at best, to use changes in MCAS scores to examine the impact computer use has on students' math achievement.

Similarly, most mathematics tests include items that test students' mathematical problem solving skills. Typically, these items take the form of word problems for which students must define a function that represents the relationship described, plug in the appropriate numbers, and perform accurate computations. While it is important for students to develop these mathematical problem solving skills, these skills are not what advocates of computer use envision when they discuss the potential impacts of computers on students' problem solving skills.

Problem solving with computers is more than just decoding text to define functions. As Dwyer describes, when developing problem solving skills with computers, "students are encouraged to critically assess data, to discover relationships and patterns, to compare and contrast, to transform information into something new." (Dwyer, 1996, p. 18). To help students assimilate, organize, and present their learning, some teachers have students use HyperCard and other multimedia tools.

After studying HyperCard use in a small set of ACOT classrooms, Tierney concluded: "Technology appears to have increased the likelihood of students' being able to pursue multiple lines of thought and entertain different perspectives. Ideas were no longer treated as unidimensional and sequential; the technology allowed students to embed ideas within other ideas, as well as pursue other forms of multilayering and interconnecting ideas. Students began spending a great deal of time considering layout, that is, how the issues that they were wrestling with might be explored across an array of still pictures, video segments, text segments, and sound clips." (p. 176, Tierney, 1996, p. 176).

These findings are echoed by teachers in other schools. After studying technology use across classrooms in one school district, Russell (2000, p. 11) wrote: "In addition to exposing students to a larger body of information related to the topic of study, creating HyperStudio stacks also requires students to more carefully plan how they integrate and present this information. As one teacher explains, 'First they do the research and identify what it is they want to include in their stack. They then create a flow chart that depicts how the pieces fit together. They sketch their stack on paper and then begin putting it into the computer.' Through this process, students develop their planning skills and learn to anticipate how information will be received by their audience."

Despite the skill development enabled by HyperCard and other multimedia authoring tools, students who develop complex, high quality products using HyperCard do not necessarily perform well on current tests. While studying the impact of computers on student learning in the Apple Classrooms of Tomorrow project, Baker, Herman, and Gearhart (1996, p. 198) found that "...a sizeable portion of students who used HyperCard well to express their understanding of principles, themes, facts, and relationships were so-so or worse performers judged by more traditional forms of testing." Over the past decade these and similar findings have led proponents of computer use in schools to conclude that technology enables students to develop new competencies, "some of which were not being captured by traditional assessment measures." (Fisher, Dwyer, & Yocam, 1996, p. 5). While I support this conclusion, I also believe critics of computers in schools are beginning to see this argument as a well-worn cover for "lukewarm results" (Jane Healy as quoted by Westreich, 2000).

Upgrading Testing Methods

It is time that testing and accountability programs develop and apply instruments and testing procedures that capture the types of learning impacted by computer use. To make this happen, several steps are required.

First, educators and parents must demand that the way students are assessed matches the medium in which they typically work. Advocates for disabled students have long argued that state and local assessment programs should "allow students the same assistance in the assessment process as they have in the learning process..." and reason that "it is only fair that the assessment of what they have learned should allow for them to demonstrate their knowledge and skills in the way most appropriate to them." (Hehir, 2000, p. 50). I believe that the same argument applies to all students. Students who are accustomed to writing with computers in school or at home should be allowed to write with computers while being tested. Similarly, as some testing programs have begun to allow, students who are accustomed to working with graphing or traditional calculators should be allowed to use these during tests (with the exception of tests that measure students' ability to perform calculations).

Second, educators and advocates of computer use in schools must insist that testing programs develop tests that measure students' technology skills. Despite the large investments schools have made in computer-related technologies, only two states collect information about students' technology skills. And, until recently, paper-based multiple-choice tests were employed in both states. Although teachers use computers to help students develop a wide variety of skills, a thorough examination of the impacts of computers on student learning must include measures of students' computer skills. As Westreich notes, what are often termed basic computer skills such as keyboarding are in fact "important skill[s] that one needs in order to take maximum advantage of technology" (1996, p. 23). During the past decade, many observers have also touted these skills as essential for the workplace (see Smith 1999 for a fuller review of this literature). For students who do not have access to computers at home, the development of these essential computer skills represents an important impact of computer use in schools.

Third, instruments that measure the "other types of learning" possible with computers must also be developed. But, before these instruments can be developed, educators and researchers must be clearer about what these new types of learning are. It is not enough to say that computers allow students to develop problem solving, simulation or modeling skills. Test development begins by defining the domain and constructs to be measured. Catch-phrases like problem solving, simulating, and modeling do not provide clear descriptions of a domain or construct. As an example, researchers at the Educational Testing Service are currently developing a computer-aided assessment task that will test students' simulation skills. During a review of a preliminary version of this task, questions were raised as to whether the task was intended to test a student's ability to develop a simulation of a scientific experiment or use a simulator to simulate a scientific experiment. Although computers are used in schools to develop both types of skills, there is a clear difference between the two types of skills. To assist test developers, descriptions of these "new types of learning" must become more precise.

Finally, we must anticipate that computer-related technology will continue to evolve much faster than the technology of testing. Although I cannot predict what tomorrow's computer-related technologies will look like or what types of learning they will enable, we must narrow the gap between emerging computer-related technologies and new testing methods. The problem is similar to the disjuncture between the research community's findings about technology and what teachers have learned from these studies. To remedy the gap between research and practice, Norris, Smolka and Soloway (1999) recommend that researchers collaborate with teachers, curriculum developers, psychologists, and other professionals who work with students to find out what information is truly useful for educators. Similarly, I argue that researchers must work more closely with test developers, developers of new educational technologies, teachers, cognitive scientists, and students to predict how these new technologies might affect student learning and to develop instruments that measure these constructs before these new technologies have permeated large numbers of schools.

McNabb, Hawkes & Rouk are correct: "Standardized test scores have become the accepted measure with which policymakers and the public gauge the benefits of educational investments"(1999, p. 4). Acknowledging this as reality, educators and researchers must be proactive in establishing administration procedures and instruments that provide more accurate measures of the types of learning educational technology is believed to impact. Until these instruments and procedures are penned, testing programs will forever be mis-measuring the impact of computers on student learning.

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RESEARCH STAFF

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Walt Haney ||| Lisa Jackson ||| Michael Russell

BIOGRAPHIES

Walt Haney, Ed.D., Professor of Education at Boston College and Senior Research Associate in the Center for the Study of Testing Evaluation and Educational Policy (CSTEEP), specializes in educational evaluation and assessment and educational technology. He has published widely on testing and assessment issues in scholarly journals such as the Harvard Educational Review, Review of Educational Research, and Review of Research in Education and in wide-audience periodicals such as Educational Leadership, Phi Delta Kappan, the Chronicle of Higher Education and the Washington Post. He has served on the editorial boards of Educational Measurement: Issues and Practice and the American Journal of Education and on the National Advisory Committee of the ERIC Clearinghouse on Assessment and Evaluation. For the last several years, Haney directing a CSTEEP project aimed at implementing new models of assessment in schools developed under the Co-NECT project of Bolt Beranek and Newman, Inc. with funding from the New American Schools Development Corporation. He has also served as an expert witness in federal court cases concerning testing and assessment (for the Office of the Attorney General of New York and the U.S. Department of Justice) and has consulted on a case in which it is alleged that the National Merit Scholarship program has been discriminating against women.

Among other current special topics, Haney is interested in educational applications of the World Wide Web, using innovative forms of assessment (such as children's drawings and computerized assessments) to make assessment more educationally useful, an anomaly in the results of the National Assessment of Educational Progress, and cheating on tests (and statistical methods used -- and sometimes misused -- to detect cheating).

In the past three years, Walt and others have been investigating the use

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of student drawings as a means of documenting the educational ecology of classrooms and schools.

Statement of Interest

I first used drawings in research with refugees in Laos in the early 1970s and with graduate students studying alternative forms of inquiry about technology in the 1980s, but it was not until 1994 that drawings were used in one of CSTEEP's research projects. In 1994, I began including lectures and exercises on drawings in graduate courses on research methods at Boston College. While drawings clearly afford a limited picture of what occurs in schools, we are strong advocates of employing multiple methods of research and evaluation. In the research proposed, we devote more attention to drawings than to other means of assessment, not because we think that other forms cannot yield important perspectives on what goes on in schools and classrooms; rather, we focus on drawings simply because this form of assessment has been so widely neglected in educational research in general and in particular as a window through which students' perspectives on education and schools can be made visible.

Lisa R. Jackson, Ph.D., is an assistant professor in the Developmental and Educational Psychology program at Boston CollegeÕs School of Education. Her areas of specialty are child and adolescent development. Her research interests include the schooling experiences of students of color, and ethnic and gender identity development. Her current work includes a research/intervention effort exploring the relationship between self-concept and school engagement for African American adolescents.

Dr. Jackson has taught at both the post-secondary and secondary level. Prior to her position at Boston College, Dr. Jackson was involved with policy analysis and project evaluation at a private policy firm in Washington DC. There she conducted research and analysis of public policy issues in education including migrant education, integrated services, Chapter 1 programs, national school reform, and academic instruction. Other evaluation work includes serving as an evaluation consultant for the National Association for the Education of Young Children, and the Center for Collaborative Change in San Francisco, California.

Statement of Interest

My primary reason for becoming involved in this project lies in my interest in students' perceptions of schooling experiences. Research in education has highlighted the importance of students' engagement in school, a sense of belonging in school, and teacher expectations of students as being important to the outcome of their education (i.e., academic performance). Much of our knowledge in this area comes from traditional quantitative measures that tell us little about the quality of student experience as determined by criteria defined by the students themselves. Student drawings have opened up the window to information about the quality of students' experiences in schools that can only contribute to our broader understanding of schools and how they work.

This research is also closely related to work I have done in the past. I have looked at the schooling experiences of African American and Latino students as well as the experiences of boys and girls within these groups. While much is know about these students' academic performance, little is known of their perception of their schooling experiences. I hope through this project to highlight these students' experiences and to look at the relationship between these students' experiences, their teachers' interpretations of these experiences, and students' overall performance. In addition, as a developmental psychologist, I am interested in how these perceptions change over time. Comparing student drawings from elementary to middle school (and possibly from middle school to high school) can provide us with an understanding of the importance of these transitions for continued positive school engagement and investment. One example is the change in experience for girls in their interest in math and science. Research tells us that this interest diminishes as girls proceed through school. How are girls' perceptions of math and science changing over time? What classroom factors are they highlighting in their drawings that can help identify the reasons for their change in perception? By uncovering this information and working directly with schools and teachers, we have a chance at improving the ecology of classrooms such that we positively impact the schooling and academic experience of students. Given that the original focus of this research is school reform both at the school level and the teacher level, I think it is imperative that we bring to the foreground the experiences of students. For it is their experience that we ultimately want to enrich. Without their perspective, our vision for improvement is greatly narrowed.

Michael Russell, M.Ed., is a Research Associate for Boston College's Center for the Study of Testing, Evaluation and Educational Policy. In addition to his work on the Drawing on Education project, Russell also directs assessment activities for the Vanguard Project, a project funded by the National Science Foundation to study strategies for initiating and supporting systemic change across school systems. Through a grant from the Edna McConnell Clark Foundation, he works with several school districts to improve reporting practices and to use student level data to inform school wide strategies. Michael was the principal investigator for a project in which he worked with schools receiving support from New American Schools to implement comprehensive, school wide assessment programs.

Russell works regularly with teachers and administrators to use assessment results to establish and measure school-wide goals. He has designed and authored computer based assessments, custom data entry/analysis tools and item data bank/search engine and initiated a study on the effect writing assessments performed via paper-and-pencil has on the responses of students accustomed to writing on a computer. He has taught courses on Classroom Assessment and Assessment and Standards. Russell is currently completing the Ph.D. program at Boston College in Educational Research, Measurement and Evaluation.

Statement of Interest

During the past four years, we have used drawings to collect information about classroom practices and to engage teachers in reflecting on their practices. We have found drawings are an effective way to stimulate conversations about teaching and learning. Until recently, however, we have not thoroughly investigated the extent to which drawings accurately capture classroom practices. In this project, my work will focus on issues of validity and reliability. Specifically, I will explore the following questions: How well do drawings capture teaching and learning in the classroom? How stable are classroom images over time? How reliably are drawings analyzed and how valid are the conclusions one draws from images of the classroom?

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ICE MACHINES, STEAMBOATS, AND EDUCATION:

STRUCTURAL CHANGE AND EDUCATIONAL TECHNOLOGIES

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ICE MACHINES AND STEAMBOATS

Every revolutionary technology starts with a whimper. Its full revolutionary bang is realized only later after fundamental structural changes are made to accommodate the new technology.

Paul Horwitz likes to remind us that the first ice making machines were introduced when everyone used iceboxes to store food. Ice companies delivered blocks of ice for these iceboxes once or twice a week. Of course, the first ice machines were used by the ice companies to make ice for home iceboxes. It took decades until the ice companies vanished and everyone had personal ice machines, called refrigerators.

Steam engines were first put on sailboats to solve a persistent problem: time wasted in the doldrums. When there was no wind, the steam engine was fired up and used only until there was enough wind for sailing. Steam was initially viewed as a solution to a problem for sailboats, not as a replacement for them. But, of course, in the end sail power vanished and steam permitted faster, larger, safer, all-metal ships that could move goods faster and much more economically.

There are countless examples like these in the history of technology, where a new technology is first used to address a narrow problem within the existing order and only later overthrew the old order. The delay is inevitable because structural changes are needed for the new technology. In the case of ice machines, universal access to electricity and lower costs through mass production were needed before everyone could buy a refrigerator. In the case of steamboats, deeper harbors, new construction techniques, and railroads to supply coal and remove cargoes were needed before large, steel steamers made sense.

There is dawning realization that the current economic boom has technology to thank because of the structural changes it has caused in business. Productivity is up because technology means that fewer managers are needed, businesses are far less hierarchical, and financial markets have been democratized.

In spite of the decades that computers have been around and their current high use in schools, we have yet to see the revolution they could cause in learning. Educators are still delivering block ice made by ice machines, still using steam only in the doldrums. This is because business competition rewards improvements while education is organized to conserve and pass on the best of the old. In addition, education is highly labor-intensive, and the cost of labor has been bid up by the buoyant economy. We are, nevertheless, overdue for a surge in education performance driven by the technology, as soon as we are willing to make the necessary structural changes. This will profoundly improve education.

TECHNOLOGY TRENDS

Before jumping into the specifics of the educational change that technology will cause, it is important to understand where we are in the information revolution and where it is going. We must look at not only the technology itself, but also the structural change society must make to accommodate it.

Moore's Law

We are only part way through fundamental improvements in the technologies that enable computers and networks. The technologies we see today will look feeble and clumsy tomorrow because the technological revolution is far from complete.

One indicator of this ongoing change is "Moore's Law", an observation made by Gordon Moore in 1965, several years before helping start Intel. Moore observed then that the number of transistors on a microchip was doubling every 18 months. As Figure 1 suggests, this incredible rate of advance has remained true for 30 years, and could for another 30.

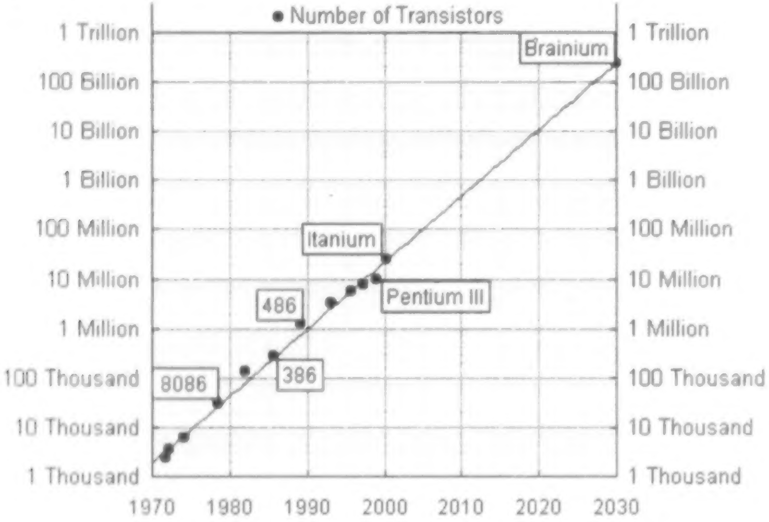

Figure 1. Moore's Law. *Note that the vertical scale on this and the next graph is logarithmic. Source: http://www.chartoftheday.com/20000719b.htm*

This kind of exponential change applies to the entire information industry, not just computer chips. In 1995, I collected historical data on hard drive costs from advertisements in old magazines. The result is graphed in Figure 2 and extrapolated to 2002. These data show that the cost of 1GB of storage has dropped by a factor of two every year. I recently checked the data for 2000 and found that my pre-1995 prediction was correct within the width of the line. Similar exponential increases in performance will be seen in all components: displays, keyboards, and media.

This unprecedented level of change is certain to have huge consequences. For comparison, Figure 2 shows the factor-of-three decrease in costs achieved by Henry Ford over six years. This change democratized the automobile, led to malls and suburbs, and revolutionized all kinds of manufacturing through mass production. Ford's innovation is miniscule and glacial in comparison to the decades of annual factor-of-two change in computer and networking performance we are witnessing.

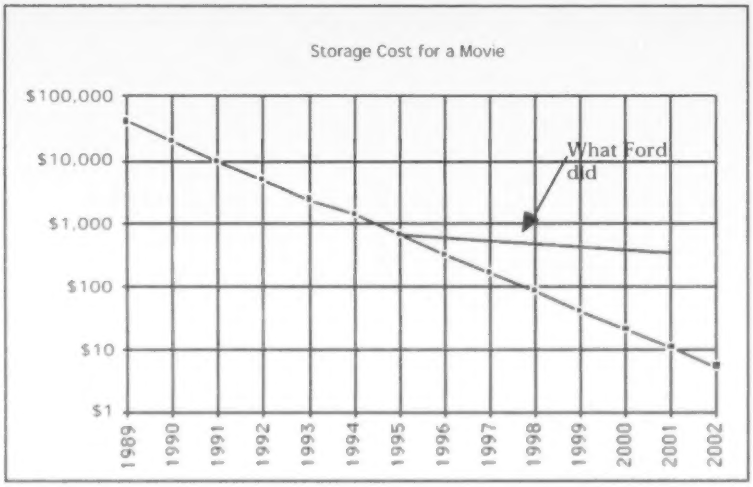

***Figure 2. Costs of storing a compressed movie on a hard drive**. Based on data for 1989-1995. The other points are extrapolated but are accurate for 2000.*

Experts expect these changes to continue 10-20 more years, but no one really knows. The result might be a trillion-fold increase in performance since 1965 and a million-fold increase from today. It is impossible to predict what new applications that these improvements in the underlying technology will enable, but it is certain that the structural changes necessary to exploit them fully in education will take additional decades.

We are helping write the script of the opening scenes of the most dramatic play educators have ever witnessed. Our grandchildren will write the final scene and their children will enjoy its impact.

Ubiquity and Convergence

A direct consequence of the ongoing revolution described above, in only a few years computers will be very inexpensive and ubiquitous. Each person will own several and have easy access to more--all able to communicate over the Internet. Toys, TVs, phones, pagers, handhelds, and general-purpose computers will have access to the net. Wireless access will become common and switching between wired and wireless connections will be effortless.

There is great concern that this will only lead to another wedge between rich and poor, the "digital divide". Figure 3 illustrates the situation. In terms of classroom access to the Internet. The poorer schools appear to be about two years behind the richer ones. This difference is inexcusable, but using my projections[1], the rich-poor numerical difference almost vanishes as both approach 100% access by 2002.

Any indicator of technology access in the U.S. will show a similar behavior over the next decade, showing a gap that dwindles into insignificance as prices drop. This is because information technologies are relatively low-cost and dropping. Unlike jets, reactors, and rockets, computer and network technologies are "democratic technologies." Like TVs, VCRs, calculators, and radios, information technologies are soon to be ubiquitous.

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[1] The projected data represent a fit to an arctangent function. Because there are only four points of data, there is considerable uncertainty in the projection.

The vanishing of the digital divide defined as access to technology in the U.S. will not, of course, rectify the deplorable inequities in U.S. schools. Because of inadequate funding and more difficult working conditions, too many poor schools will not use the technology well, will be unable to maintain it, and will provide fewer opportunities for their teachers to exploit it. The result will be continued poorer education in many poorer schools. The cost of access to technology will not contribute significantly to this persistent, essentially political, problem. If anything, the technology, by providing free access to increasingly valuable resources, will have a leveling effect that will tend to reduce the gap.

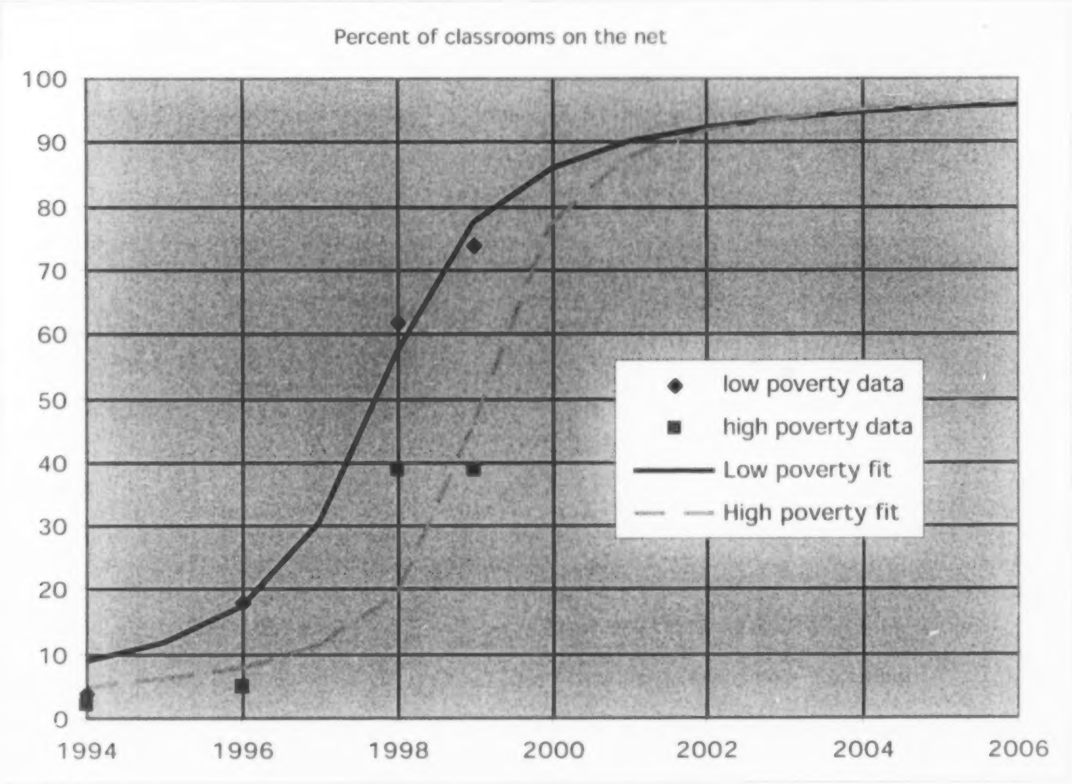

Figure 3. The Digital Divide: Percent of U.S. Classrooms with Internet Access by Poverty Level. *The top graph is for schools with fewer than 11% of students participating in free or reduced lunch programs. The lower line shows schools with more than 70% participating. The gap is one measure of the difference between schools serving rich and poor communities. Data for 1994-1999 are shown, the curves are extrapolations*[2].

The situation throughout the world will be essentially similar, with the exception of much of central Africa. In most parts of the world, the huge digital divides that exist today will close as access becomes ubiquitous. Many countries already exceed the U.S. access to technology and even developing countries see the importance of computer and networking technologies and are making them widely available.

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[2] http://nces.ed.gov/quicktables/Detail.asp?SrchKeyWord=Internet+&Key=277&optSearch=Exact&quarter=&topic=All&survey=All&sortby=

Ubiquity will be accompanied by increasing reliance on the network to synchronize data. You want your personal mailing list to be on your cell phone and TV computer. If your student masters multi-digit subtraction in school, her educational games at home should take advantage of this and her parents should be informed. Data collected on a colleague's handheld computer should be available on your portable. All these feats of synchronization will happen automatically and effortlessly through the network. The location of the data will not matter; you may choose to store your data on your main computer's hard drive, a server in Budapest, or for security, your personal smart card.

It is quite likely that each learner will have a net-based educational profile that can change as the individual learns. This is how a student's progress can be monitored, shared among different computers she uses, and reported, as appropriate, to parents and others responsible for her education. Leapfrog, a maker of educational toys, is already planning a line of mass-produced products based on this principle.

An online educational profile is a potential privacy bombshell. Everyone will want tight and secure control over who looks at grades, test scores, progress, weaknesses, essays, and preferences. Technology can solve this, though, through some combination of encryption, a smart card that physically controls the data, and related software.

Technology Characteristics

Before projecting educational uses of technology, it is useful to summarize the unusual characteristics of networking technologies. These characteristics have led to the Internet's impact on commerce and have dictated the structural changes needed to exploit fully the technology in business. We can look at these for hints about the similar structural changes needed in education.

Open Source

No one owns the Internet. The power of the Internet is that almost anyone can contribute to it and there are ways to find anyone's contribution. This could lead to the junk and misinformation drowning the relatively rare pearls. This is unlikely, however, because the decentralization also supports self-appointed annotators and collectors of links that provide vetting and review functions. In fact, this self-publishing feature has unleashed tremendous human creativity. Every corporation, government agency, school, town, association, group, museum, and individual wants to put their best on the net.

One of the most dramatic manifestations of the ethic of sharing that the Internet has spawned "open source". The open source movement is highly decentralized, but rallies around the idea of the GNU Public License (GPL) as an alternative to conventional copyright protection. The GPL states that anyone can use the source code without charge providing the user protect any improvements with the GPL license. Companies can sell the software, providing that they continue to make the source freely available. The result is that the source code stays public and keeps getting refined.

GPL software can be better than software simply placed in the public domain, because the terms of the GNU license stop anyone from grabbing the public code and making it proprietary. The result is code that everyone is motivated to review and improve the code. Code that survives tends to be lean, elegant, stable, and free.

Initially, open source software focused on the Linux operating system software, but this is changing rapidly. The people shaping the effort insist that system software is only the beginning. Because open source development is the best way to create reliable and elegant software, they are certain that most software will eventually be distributed under the GPL. The open source motto is "Software is meant to be free."

They may be right. Already the open source idea has reached far beyond Linux. In addition to the Netscape browser, there are now open source spreadsheets, word processors, a presentation package (like PowerPoint), and gimp, an image manipulation program that is better than PhotoShop. The open source software idea is beginning to appeal to corporations, because it offers an inexpensive way to incorporate free software into their product and get better product support than they can afford to hire. All Netscape's code is open source, as is much of the next generation Macintosh operating system. IBM is installing GNU/Linux into some computers.

Globalization

The U.S. has led the world in Internet use and implementation, but the rest of the world will overtake us soon. The largest growth in Internet use over the next few years is expected in Latin America and Asia. According to Global Reach, currently, 49% of the 335 million Internet users worldwide are non-English speaking. In 2003, the 670 million non-English users will be more than double the number of English-speaking users. There are already 18 million Chinese users and there might be 125 million in 2003[1].

While these projections are open to question, the general trend is not. The majority of the educated population of the world along with most of its institutions will be strutting their stuff online in a few years. These new users will bring a rich collection of new resources and interests to everyone. The world's books, art, data, pictures, animations, music, simulations, poems, and much more will be available. Collaborators, collectors, mentors, advisors, and consultants for every imaginable topic will be a few clicks away.

Unfortunately, all kinds of undesirable resources will also be increasingly available. There will be the entire world's junk, smut, hatred, violence, stupidity, superstition, and insanity. Every form of vice and bad habit will be represented, too. Even more viruses will be circulated and more attacks on computer systems mounted. In addition, the Internet is rapidly becoming commercialized. Some of the most amazing services are available free, subsidized by advertisers. Computers, email, storage, faxing, news, music, search engines, financial data, and much more are available free because they are paid for by advertisers.

There is no point in avoiding the Internet because of these undesirable aspects. We have to face the problems and learn to minimize them. One of the skills we will need to learn is how to find the good, reliable stuff for ourselves and youngsters in our charge while avoiding the bad.

DREAMS OF TRANSFORMED EDUCATION

Given these trends and directions, what are the implications for precollege education? What kinds of change will be the most important over the next decade? How will these changes affect schools, teachers, and students? How can these change best be managed? It is impossible to answer these questions with any confidence, but there are some areas that are quite promising that I would love to explore.

My work consists largely of writing proposals about ways technology might help education and helping launch the ones that are funded. I have a magnificent staff that converts the dreams we write about in proposals to real projects that help us glimpse into the future. We try to propose work that is important, original, and path breaking. However, our proposals are frequently rejected. In this section, I have dusted off some of my favorite rejected proposals. I like to think that these have been rejected because they are too far ahead of the funders, not bad ideas, or poorly written projects.

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[1] Source http://www.glreach.com/globstats/index.php3

New Tools

Software tools have revolutionized business and hold the key to breakthroughs in education as well. Software tools are general-purpose, flexible applications that you can apply to your specific needs. In business, spreadsheets, presentation software, and communication tools have empowered workers to make decisions and marshal resources without the need of levels of hierarchy. Design tools have sped the development of new devices and software, increasing productivity.

In education, tool applications will also lead increases in learning and productivity in all disciplines. Literacy tools are revolutionizing the language arts, design tools have broad application across the arts and engineering, and conceptual tools will completely change all technical and social science learning.

For a tool to be educational, it needs to be part of an instructional design. Software can help there, too, especially if the tool and pedagogy are separated. All these new tools will be too expensive to develop from grants and corporate investments but open source can solve this problem.

Literacy Tools

Technological tools will become increasingly important in teaching literacy and second languages to children, adults, and special students. Over the next few years, there could be important breakthroughs in technology-enhanced literacy learning, because there is a convergence of developments:

Voice recognition. Research is underway on computer recognition of children's voices and speakers with accents. This ability can be used to recognize reading, judge accuracy, and shape pronunciation.

Ubiquitous technology. The coming inexpensive ubiquitous computers will give all learners could access to inexpensive literacy tools.

Networking. Students can use networks to find an audience for their work, a community of interest and collaborators for their investigations.

Game machine quality simulations. The incredible graphics capacity of new 128-bit game computers may create the emotional impact that can capture any learner's imagination.

Embedded assessment. Computer generated material can continuously evaluate student reading and writing, reducing wasted testing time.

Inexpensive handhelds will soon be able to exploit these developments to provide interactive voice generation and recognition. With embedded assessment, the material can advance as fast or slowly as the learner needs. Playful content will be available for young readers while vocationally-relevant material will better suit adults.

While human intervention, motivation, and supervision will be necessary, the ubiquitous technology and software tools will greatly reduce the amount of teacher time required for literacy instruction. The bulk of the reading, listening, and correcting can be shifted to the computer, resulting in huge productivity breakthroughs. This could result in literacy gains worldwide, while decreasing tne advantage families have that can find the time to read to their children extensively.

Design Tools

Software tools that support creativity are one of the great gifts of computers. Design tools for Web development, robot programming, and music composition are available and increasingly used in education.

Design as a subject is under-represented in schools today. Design is at the core of engineering, architecture, many technologies, and art. The success of many businesses depends on their technical and artistic designs. Successful designs depend on planning, testing, knowledge, and artistic sensibilities. A central goal of education should be to foster these skills.

Perhaps the root of the lack of emphasis on design education has been a perception that design consists of two parts that each seem to be problematic. Its creative side has lacked expression outside art class and may seem too intuitive and lacking in theory that would give educators something to teach and evaluate. Design's other face is technical and may be judged as too difficult and abstract for pre-college students.

Again, computers and networking provide tools that can solve both problems. Tools for Web authoring, image manipulation, drawing, and 3D rendering allow students to be creative and share their creations with others. There are meaningful concepts and skills students need to acquire in all areas of design that can be gained through the use of these tools. On the techncial side, design and modeling tools can help students understand the technical ideas underlying design without having to master abstract mathematics or complex programming languages.

Logo and its extensions—Boxer, StarLogo, NetLogo, and Microworlds--represent one important set of tools that make design education feasible at the precollege level. Logo has gotten a bad rap in education because it was ahead of its time. It was embraced by pioneers as THE answer to "computer literacy" and subsequently widely adopted for all the wrong reasons. The resulting backlash has left many educators with a persistent bad taste. This is unfortunate, because the Logo idea and the work of its inventors from MIT's Media Lab have articulated a new approach to education based on design.

Schools need to increase greatly their emphasis on teaching design. This will require fundamental structural changes in education. New goals will have to be articulated, standards articulated and courses developed.

Tools for Concepts

Profound learning happens when models student build to simulate reality meet data students collect. The combination of sophisticated data acquisition from probes and Internet databases with models that can be compared to data, can lead treakthroughs in learning.

An example might be helpful. "Kinetic Molecular Theory" is commonly taught in middle school science. The usual approach is to introduce a series of postulates roughly along the lines of "in an ideal gas, there are no attractive forces between molecules. These molecules act as point particles that bounce off on another like pool balls without loosing energy." It is then asserted that these postulates predict the gas laws, but no justification is provided for this assertion.

This must leave most students quite perplexed. First, the "ideal" gas is clearly incorrect; its molecules are not point particles, and there are forces between them. How can a "theory" built on these patently incorrect assumptions lead to "laws"? Why should students take on faith that the postulates predict the gas laws? What does this tell students about theories, laws, and the conduct of science? The inaccessibility to students of the derivation of the gas laws makes science itself seem inaccessible.

It is now possible to give students a computer model of large numbers of atoms in a container. Students can change the size and forces between atoms and measure the resulting relationships between pressure, temperature, and volume. They can see how these macroscopic properties emerge from atomic properties and interactions. The gas laws are obvious consequences this system, as is phase change, latent heat, and crystal structure. Using probes, the gas laws and latent heats predicted by the model can be quickly verified in real systems.

Instead of the apparent complexity and inaccessibility of KMT as usually treated, this technology-rich approach clarifies the underlying concepts and relates the non-ideal properties of real liquids and solids to an ideal gas. The entire vocabulary of "ideal gases" and "KMT postulates", as well need to assert without proof that there is some relationship between the two, becomes unnecessary. The result is that students learn at a deeper level without encountering the confusion and apparent contradictions inherent in the usual approach.

We can teach ideas like KMT more deeply because the computational power of modern computers give us a new way to understand abstractions. Until computers, the only way to relate the postulates of KMT with the gas laws was through formal mathematics and the advanced undergraduate level. Students had to wait that long for a fully satisfactory understanding. Even then, the formalism is so difficult, students often fail understand the science. Thus, educators at the precollege level have no choice but to present the material as facts that must be memorized and taken on faith.

The combination of computer-based data collection and modeling can cause a breakthrough in student learning because it provides an alternative and more accessible way of understanding abstract concepts. Instead of using complex formal methods, a higher degree of student understanding can be gained by interacting with a suitable model. Deeper learning accessible to more students can be expected in all the sciences, mathematics, technical fields, quantitative social sciences, and business. Genetics, macro-economics, chemical reactions, evolution, space shots, fire fighting, the stock market, global warming, epidemics, urban planning, and much more can be better understood through DOING it with a model than reading about it or trying to understand it through mathematics. The result will eventually be that many more abstract concepts will be taught at the pre-college level. This is essential to our economy because it is exactly these abstract ideas that fuel our economy.

This breakthrough will have profound effects on special students. For some, this will be liberating, for others, the increased emphasis on conceptual understanding will be make math and science even more baffling. The shift will probably catch many special educators napping who rely heavily on software for drill and practice. Since few special educators are strong in the concepts of science, math, and technology, becoming more concept-focused will put more pressure on classroom teachers to adapt to the needs of special students.

A major structural change will be needed to take advantage of modeling and data analysis tools. Teachers will be needed who have a deeper understanding of their subjects and who know how to teach these concepts with the appropriate use of educational technologies. Educators at all levels will have to adjust to the increased learning that is possible, including the test makers, standards setters, colleges, and schools of education.

Tool Scaffolding

I argue that technology-induced advances in student understanding will be build largely on the increased use of educational tools. Unfortunately, tools have proven hard to use in education. Makers of educational tools have always had a problem: do you produce a simplified version for the learner or one with every conceivable feature for the expert? The stripped-down version is hard to sell because some other tool will have more features and get a better reputation. On the other hand, a full-featured tool is hard for teachers and students to master.

One alternative is to add educational content into the tool. One form of this is "scaffolding", a variety of helping strategies that fade away as the user becomes more expert. Context-sensitive help, that annoying assistant-in-a-window in Microsoft Office, and tutorials are other strategies to address this problem.

The alternative is to separate the tool from the pedagogical software. The tool should have no pedagogical strategy built into it. Instead, it should have "hooks" to a second software package we call Pedagogica. This is an application that is designed for controlling tools to achieve learning objectives. Pedagogica can control how many options the user sees, sense what users do with a tool, and interact directly with the user. By changing the script that Pedagogica executes, it can provide help, scaffolding, or the full-featured tool. This means that the educational strategy is not determined by the tool and can be changed to adapt to the needs of the curriculum and students.

One of the benefits of a tool like Pedagogica is that it can provide embedded assessment. The script that controls what material is presented to students needs to make judgements about what to present. This requires assessment of student learning that can be embedded in the tasks. For instance, consider the script that is used with a model of atoms in a box to teach that pressure and temperature are proportional under some conditions. The script can observe whether a student has considered enough conditions to make this prediction. It can suggest new conditions and then observe what generalizations the student makes. Watching and guiding this kind of problem solving will give the software detailed data on what the student knows and can do. These data are essential for the software to provide useful guidance. It also provides invaluable assessment data. The software can tell what a student has done, how long it took, how many blind alleys were pursued, and how persistent these errors were.

We are building a graphical interface for Pedagogica in which the script closely resembles a concept map. This will allow educators to think in terms of concepts and understandings that are familiar and closely related to the mental models we hope student will develop. Pedagogica is very much a work in progress, but something like this is needed to unleash the educational potential of general-purpose tools. We need to reach broad agreement on the need to separate pedagogy from tool applications and for the technical specifications of the "hooks" tools need to communicate with something like Pedagogica.

Open Source

How are we going to produce the tools that could revolutionize education? It is rare that grants for educational research provide sufficient funding for new tools. Surprisingly, industry also seldom concentrates enough resources for a new tool. It seems that the educational market is too small and slow to respond for businesses to risk the development of new educational tools. Open source provides the best way to develop the needed educational tools.

Open source software exists outside the normal commercial distribution channels, but supports commercialization and a flourishing service industry. Businesses, from startups to IBM and Microsoft, surprisingly have learned to embrace open source. On the other hand, education has essentially ignored it.

Why is there so little open source software for education? The only significant educational open source is a version of Logo by Brian Harvey and a productivity package, Star Office, that could see broad use in education. NSF sponsored research sometimes yields valuable educational software that is free during development, such as various versions of StarLogo, Image (image processing software), and Biologica (genetics simulations). Technically, these are not open source, since their developers retain the right to commercialize the software eventually.

One of the reasons for the paucity of open source educational software is that the open source may need to be nurtured through enlightened self-interest. Once there was a critical mass of open source system software it was in everyone's interest to expand that core. If a hacker needed a Linux driver for an obscure printer, he or she would write it and be bound, under the terms of the GPL, to contribute it to the common good. There was also recognition from gurus for solid, well designed contributions. This suggests that educational open source could provide general-purpose languages, tools and simulations, especially if it was seeded with a critical mass and there were recognition for important contributions.

The critical difference between the current open source system and its possible application to education is the consumers. In the former case, the consumers are techies who can use the software with little or no assistance or ancillary information. In education, the consumers are non-technical teachers and will need curriculum materials and professional development to use open source software. Perhaps this is not as large a distinction as it appears, however. As the interest in open source has expanded, intermediaries have sprung up who consolidate and test open source software, provide documentation, and make it self-installing so that even non-technical users can install it.

Open source educational software is certain to receive increased interest as other countries begin to explore educational applications of technology. For instance, open source educational software is already beginning to make an impact in Mexico. A university-based group had developed a graphical user interface for Linux and some applications that are being distributed free to all schools. Compared to the U.S., education in most other countries is more centralized, more closely connected to higher education, and far less likely to spend money on commercial software. As a result, there will be funding for software that will be distributed freely to schools. Since each country will have similar needs, it makes sense that software development be shared, and open source offers the best alternative.

If funding is provided to seed and coordinate an international educational open source movement, we could unleash the kind of global creativity that has created and expanded open source software for business. The educational open source effort should concentrate on general-purpose tools with standardized hooks for pedagogical controllers like Pedagogica. If educational open source started this way, then enlightened self-interest could accelerate the process. General-purpose tools could find worldwide application. Scripts would adapt the tools to the special needs and goals of specific countries and regions. If tools and scripts were open sourced, then every developer would have a powerful incentive to adhere to open source rules.

There is certain to be thousands of bright, creative programmers throughout the world who would be thrilled to have the chance to contribute to improved education everywhere. The resulting educational tools and pedagogical scripts could be far more sophisticated and extensive than anything we can hope to develop through grants and business investment. A coordinated effort to seed open source development could yield a rich harvest of educational applications that would be far better and broader than current software and completely free.

The New Textbook

This vision of learning that relies on tools guided by scripts using open source software leaves little room for traditional textbooks. Current science texts for high school courses can exceed 1,000 pages and weigh more than a portable computer. They require, with associated materials, years and millions of dollars to develop. The texts must include every topic any significant sub-audience might want, while avoiding potential controversies. This huge investment results in high prices, the use of copyrighted content, and the inability to include public domain materials. This approach to curricula yields heavy, expensive books that are frozen in time. Even if they include software and Web pages, these ancillary materials only begin to scratch the surface of what is possible. They certainly fail to include sophisticated modeling and data collection tools. The textbook-based approach to teaching science is too limiting and too inflexible; it belongs to the prior century.

The realization of the power of technology requires a structural change in curriculum design and dissemination. Let's stop thinking of a textbook and substitute instead online tool-based curriculum resources that are far richer than simply an online textbook. The value of a textbook and its ancillary materials is that it represents a coherent *aggregation* of resources and educational activities. Technology can provide the benefits of aggregation while avoiding the costs, inflexibility of a text and constraints of needing to own all the materials.

This aggregation can be achieved through a flexible online curriculum framework with "slots" for modular digital materials that adhere to high standards. These slots might feature lab activities, software-based investigations, discussions of videos, structured investigations of a model, or research projects. The modules that fill the slots will come from sponsored educational R&D, academic researchers, teachers, or businesses. This modular structure would ensure far faster integration of materials originating in R&D labs that now often languish without a publisher.

It is often incorrectly assumed that relying on digital materials isolates learners and deprives them from opportunities for direct, hands-on learning. It is certainly possible and desirable to include in the curriculum collaboration and discussions both online and in-class and also give students ample opportunities to hands-on learning using probeware, off-line projects, activities, and field studies.

A complete curriculum would consist of a framework with all slots filled with excellent, highly interactive, research-based materials that take full advantage of data and modeling tools. The result will be richer than a text, because it will provide interaction, computation, and collaboration in the context of learning resources.

A complete set of curriculum materials of this sort for a course might be produced with the same care as current texts, but be based on modules that can be easily modified or substituted for other materials as they become available. States and districts could modify the materials to fit their standards and interests. The modules requiring specialized labs, software, or technology could be modified to fit whatever a school has implemented. Some modules would be free, others would be licensed with a small fee in lieu of the textbook purchase costs, going to the authors.

Implementing these online curriculum resources will require that all students have easy access to computers and networking. As shown in a Figure 3, this will require a few more years to be fully inclusive. This is, however, no reason to fail to start exploring this alternative to texts now. By the time high quality, fully integrated digital curriculum frameworks can be developed, filled, and tested, the technology will be ubiquitous.

Online Courses

Tools, even with excellent pedagogical software, are not going to revolutionize education alone. These critical elements need to be integrated into courses students take. The process of changing courses can be excruciatingly slow. Effective online courses are can accelerate this process by disseminating improved materials and techniques while also creating competition that can stimulate change.

I use the "effective" qualification because too many online courses are not. Most initial efforts were comparable to the first steamships. They represented a straightforward transfer of existing courses onto the net, using one-way audio or video lectures, online texts, and standard tests. To be effective, online courses need to be quite different.

Effective courses are able to engage students at a distance in collaborative, activity-based learning, in small groups guided by trained facilitators. The best approaches use asynchronous, two-way technologies that rely on carefully designed activities, good evaluation strategies, and communities of learners facilitated by online discussions. They also take advantage of the computer for simulations, models, data collection, calculations, mentoring, and creations as appropriate. Well-designed online courses are at least as good as face-to-face courses and are usually more inclusive and better designed. Only a fraction of the online courses fit these characteristics, but time will weed out the many poorer designs.

Online Courses for Students

Online courses for secondary students are exploding. At the advanced level, high school students can enroll at colleges and universities, one-third of which now offer Internet-based courses for credit. Although slower than post-secondary education to exploit the power of online courses, high schools are increasingly offering effective online courses to their students.

Secondary education has lagged colleges and universities in using online courses because few schools have the incentives or resources to offer courses themselves. Post-secondary institutions have strong financial incentives to increase income from tuitions from distant students. High schools are chartered to serve a community and cannot increase their income by stealing students from other districts. In addition, post-secondary institutions tend to be larger and better able to afford the investment required to create effective online courses.

The answer for secondary education is to form cooperatives of schools to share online courses. If each of 200 schools teaches a section of an online course, then all of their students have access to a pool of 200 course sections. Rather than competing for students in a zero-sum game, everyone gains from this form of sharing. The costs are low, too, because schools in a cooperative don't have to pay tuition. If they balance out the number of seats they create through offering courses with the number of seats their students need, there are no new instructional costs. Of course, there are administrative costs in running the cooperative and training the participating staff, but these are less than tuition.

Much to my delight, a proposal based on this radical idea was funded by the Department of Education's Technology Innovation Challenge program and resulted in the Virtual High School (see http://vhs.concord.org). Through four years of operation, we have demonstrated how such a cooperative can work. We have learned how to prepare teachers to offer online courses, how to keep standards high, and how to handle all the problems of scheduling, registration, orientation, and accreditation.

The conclusion by independent evaluators from SRI International is that students, teachers, unions, and administrators love the VHS online courses. They are personal, challenging, and interesting. The courses offer quality, flexibility, and scope that is invaluable. Their range of topics is a godsend to students with specialized interests. Tiny schools can offer a range of courses that is the envy of larger schools not in the program. At least two smaller schools were saved from oblivion because of this.

The cooperative nature of the VHS is a key innovation that will prove essential in the long run. Some states, such as Florida and Kentucky, are beginning to offer online courses funded at the state level. These are doomed because they represent a major shift of instructional costs and control from the community to the state. In the end, the states cannot afford this shift and communities and unions will not permit it. Similarly, for-profits or entrepreneurial colleges cannot expect to earn more than a tiny fraction of secondary school instructional costs because schools will want to keep those funds in the community. A larger district, however, should be able to sustain effective online courses in its high schools because it can act like a cooperative, sharing among schools instructional resources in the form of online courses.

Once the idea of online courses takes off, it could force some much-needed change. Advocates of vouchers and charter schools hope that the competition that their innovations introduce into education will provide incentives for all schools to improve. Cooperative online courses actually create a far more intense pressure to change, but without the competition. Once schools can offer hundreds of high quality online courses, parents and students will have little tolerance for sub-standard face-to-face courses. There will no excuse for courses that do not use technology well, that are not carefully designed, or are out-of-date. Students will protest with their feet and parents will demand access to the better online courses.

Online courses could be the quickest way to disseminate new instructional approaches that make full use of modeling and data tools. At first, these new approaches will attract only a few students. The strength of online courses, however, is that they can reach thin audiences—those adventurous students willing to try a new approach. As data accumulates about the power of these alternatives, there will be demand for additional sections. As the next section describes, we can train these teachers online and disseminate the approach widely.

The creation of educational cooperatives is an example the kind of structural shifts that are needed to exploit the information technologies. To exploit the power of online course, it is not sufficient simply to offer some courses. A set of economic, political, and practical problems must be solved which seem to demand cooperative sharing of courses.

Online Courses for Teachers

Effective online courses can revolutionize teacher professional development (TPD). They are able to deliver focused and timely assistance to teachers whenever they need it. Online teacher professional development during the academic year allows teachers to experiment with the new materials and approaches advocated in a course and then discuss the results with their colleagues. Inherently, the costs for effective online TPD are lower than face-to-face courses and workshops because they avoid transportation, food, and meeting expenses.

One of the most exciting current developments in TPD is the use of online interactive video case studies in online courses. The technology is nearing the capacity to handle video on demand, at least in short segments. This allows us to imagine that large numbers of videos of exemplary teaching could be made widely available. It is well known that video case studies, properly supported, are far more effective for teacher than hours of abstract discussions or readings of how to teach. A video shows an entire environment, illustrates how to organize classroom space and time, and how respond to students' typical issues.

Online video case studies could be made highly interactive by linking them to lesson plans, typical student work, relevant standards and assessments, background content, expert commentary, teacher reflection, and moderated online discussion groups. As appropriate to the topics, there will be links to relevant tools, simulations, and implementation guidance. At any point, the user could stop, replay, jump ahead, or dive into the rich surrounding content.

Using interactive case studies in online course will be much richer than typical workshops that use case studies. The online teacher will be in charge, able to control the pace and depth of the experience. The privacy of the experience will permit teachers to acknowledge their content weaknesses and brush up on their understanding of content and technology. On the other hand, the online discussion areas will encourage collegiality and reflective sharing around focused, relevant issues.

The rapid changes in standards, assessment, content, curricula, and educational technologies create a massive need for ongoing teacher professional development. Technology itself puts new burdens on teachers. It is increasingly clear that every school will have a unique and rapidly changing combination of computers, networking, and software. Teachers cannot rely on textbooks to provide software and network resources coordinated with the text because they cannot be sure what technology will be available. Consequently, the task of integrating technology is left to teachers.

Teachers need detailed and specific help in adapting to these changes and new responsibilities. One teacher might want ideas for modeling software to use in eighth grade mathematics, while another might be looking for curricula that integrate conflict resolution into fifth grade. A high school biology teacher might be looking for some background in chemical bonding that is now in the standards. It is very difficult for schools to provide high-quality professional development opportunities for their teachers that are so specific.

Online courses, on the other hand, can reach thin markets with excellent courses designed by the best people in the field. While enough teachers to make up a workshop from one school are unlikely to need the same highly focused course, it is likely that a critical number can be found across the country on almost any conceivable topic. To make this point, the University of Montana's NTEN project started with a course on teaching general relativity in high school offered by experts in the field. The regularly filled the course with 25 teacher participants.

Dropouts have been a persistent problem in online courses. Many teachers who are enthusiastic about online courses and praise them for what they have learned, fail to complete their courses. One exception has been the courses we offer in the VHS that are a prerequisite to teaching in the VHS. Here, unlike many TPD situations, successful completion is an absolute requirement for continuing in the project. The problem is that teachers are incredibly busy and are seldom given released time for online TPD. In addition, there are seldom strong incentives for completion. The upshot is that even conscientious teachers tend to stay enrolled just long enough to get the materials and main ideas and then leave. This means that online courses should be short and highly focused and that successful completion should well rewarded. Teachers should be able to select exactly the content they need and be able to absorb it in minimal time.

What is needed, then, is the development of very large numbers of targeted online short courses for teachers that make liberal use of video case studies. These should be a half-semester long and accredited by a rigorous, external body. Schools need to expect their teachers continually to complete short courses that fit into the school's master plan for TPD, provide released time for the courses, and link advancement to successful completion.

We have begun to explore these ideas in a one-year pilot program just funded by the Department of Education called Seeing Math. With our partners COMAP[4] and TeachScape[5], we will produce online case studies and short courses for teachers focused on grade 4-5 mathematics. We are hopeful that this project will demonstrate the power of interactive video case studies and short courses that use them.

A much larger effort is needed, however. Hundreds of case studies and short courses are needed to meet the diverse needs of teachers. This suggests cooperatives, designed along the lines of the VHS. If every district in a 200 school cooperative contributed a short course on a topic for which they had expertise, then teachers in all the participating schools would have 200 short courses to choose from. This would result in better use of existing PDF funds; the only new cost would be for the short course development and the administration of the cooperative.

Again, we see structural changes are needed to exploit the technology. In addition to the high bandwidth and modern computers needed for video-on-demand, full exploitation of the technology for TPD demands new cooperatives and accreditation functions, local support for online learning, and increased reliance on ongoing TPD.

Metacourses

Designing and offering courses online requires skill, knowledge, and discipline. The reason there are so many poor online courses is that teachers and entrepreneurs assume that this is an easy task for any teacher. To fill the need for disseminating the knowledge we have gained, we created "metacourses", online courses about online courses. For instance, in the VHS course we have developed two that are central to the success of the project. The first is a yearlong 125 hour course about designing, creating, and offering a VHS course. The second is a one-semester course on how to offer an online course. As part of a different project, we have developed "Moving Out of the Middle", a popular course on facilitating online courses. (For more about these metacourses, see our commercial partner On Line Learning International at http://metacourse.com)

The nation needs many more secondary teachers trained in online courses. If we can get to college students who are making career choices, the opportunity to teach online might help attract more well qualified students into teaching. Being able to teach online can solve the problems of two jobs for married students. The ability of one spouse to teach online vastly simplifies the choice of location and opens more options for the other spouse. In addition, online teaching is likely to be well paying because the online teacher can accept the best job anywhere. The opportunity to earn more and telecommute anywhere might be deciding factors for attracting outstanding students interested in teaching but discouraged by pay and working conditions.

As a start in this direction, we have offered the one-semester VHS metacourse to preservice students. We have long dreamed of offering virtual internships in the VHS for preservice teachers, but have yet to find funders that idea. Again, a much larger metacourse effort is needed. Schools of education and licensing agencies will have to agree that online teaching is realistic option for students and that there are important things to learn about online teaching. This is likely to take decades without a concerted research and development effort.

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[4] See http://www.comap.com

[5] TeachScape will market the fully interactive version. See http://teachscape.com

Conclusions

Schools need to undertake major changes to fully exploit technology. Students will need increased access to technology. This will make it feasible to rely more on tool-type applications. Realizing the potential gains in learning will greatly strain schools. Teachers will need increased professional development in both content and the use of technology. Online courses will provide models for how to do this along with new opportunities for professional development. Online courses will also provide the spur of competition. Students and parents will demand face-to-face courses of the same quality available online. If schools cannot meet that demand, they will loose students to home schooling or alternative schools better able to exploit the technology.

Funding agencies could greatly accelerate the changes needed to realize these dreams. Small studies are needed to find out what technology-enhanced learning is possible under ideal conditions. Large-scale, longitudinal experiments are need to work out the bugs and document the gains in student learning that are possible. Funding should be provided to develop and disseminate the needed online professional development and the training of online facilitators through metacourses. Most importantly, concentrated funding is needed to seed an international educational open source effort.

Schools and funders need to realize that fundamental structural changes are needed. While the predictions of this paper are unlikely to be terribly accurate, we can be sure that this revolutionary new technology will force fundamental changes in education. We cannot afford public education to go the way of the sailboat or ice companies. Trying to use technology to solve today's problems is like using steam power to get out of the doldrums or ice machines to make block ice. The technology offers education much more.

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Robert Tinker has, for a quarter-century, pioneered constructivist approaches to education, particularly novel uses of educational technology in science. In the '80's, he developed the idea of equipping computers with probes for real-time measurements and of using the network for collaborative student data sharing and investigations. Four years ago he started the Concord Consortium so he could concentrate on applications of technology in education. He now directs several major research and development projects and a staff of 35. Current research includes work on educational applications of portable computers, large-scale tests of online courses for teachers and secondary students, sophisticated simulations, the development of technology-rich materials for sustainable development education, and a scientific study of haze that involves students. Bob is also co-PI for the Center for Innovative Learning Technologies co-located at Concord, Berkeley, Vanderbilt and SRI International, an international center designed to stimulate collaborative, cross-sector research and development on educational technology. Bob earned his PhD in experimental low temperature physics from MIT and has taught college physics for ten years.

The Virtual High School

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DEPARTMENT OF EDUCATION · UNITED STATES OF AMERICA

The Secretary's Conference on Educational Technology 2000

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David Thornburg **Renaissance 2000**

ED HOME EDTECH CONFERENCE 2000 *This page last modified December 20, 2000 (bay).*

Crossing the Continuum

Results of Ohio's Annual Education Technology Assessment

Executive Summary

Building something and helping something to grow are two different challenges.

Building is logical and systematic. We draw up a plan, assemble the components, and put them all in place. Theprocess can be complicated and expensive with some surprises and setbacks, but progress is fairly predictable and controllable. Helping something to grow is a different matter. All we can do is create the right conditions and keep looking for results.

Both challenges are inherent in the work of Ohio SchoolNet.

Launched in 1994 to support the work of combining educational technology with new approaches to teaching and learning in Ohio's K-12 classrooms, this statewide partnership has a full agenda:

- SchoolNet has been coordinating the major task of building a physical infrastructure for connectivity and classroom technology in Ohio's schools and classrooms.
- SchoolNet also has been working to create the optimum conditions for the growth of new, technology-enriched teaching and learning practices.

This report reviews Ohio's progress in meeting these two important challenges by presenting the results of the Annual Education Technology Assessment (AETA), which was conducted during the 1999-2000 school year.

The Assessment

The Annual Educational Technology Assessment is conducted by analyzing data collected through three survey instruments: 1) a district survey, 2) a building survey, and 3) a teacher survey. The surveys were sent to every district and building in the state and could be completed on paper or online. With a return rate of 90 percent for teachers, x percent for buildings, and 90 percent for districts, confidence is high that the results are representative of the state.

The Focus: Progress Toward Eight SchoolNet Goals

The three surveys were designed to elicit information about the progress of SchoolNet and of local districts toward developing essential conditions for effective use of educational technology, as well as about how investments in creating those conditions have changed classroom practices.

Those conditions are reflected in eight SchoolNet goals that are aligned with characteristics identified by the National Education Technology Standards. The goals center on 1) connectivity, 2) classroom technology, 3) technology support, 4) technical training, 5) professional development, 6) electronic resources (instructional), 7) electronic resources (administrative), and 7) planning and coordination.

The Benefit: Better State and Local Decisions

Each district and building can access its results--including aggregated teacher responses -- via an interactive, searchable Web site. These results can be used in a variety of local planning and budgeting activities.

Profiles of statewide aggregated data are available for determining major trends and needs across the state. For this report, data in a number of areas have been further analyzed to identify relationships and patterns among responses.

The Eight SchoolNet Goals

Connectivity
Every school classroom is able to connect to a statewide network that provides students and teachers consistent access to electronic resources and the Internet. This network would also allow students and teachers to collaborate statewide in their daily work.

Classroom Technology
Students and teachers have access to modern multimedia computers, distance learning, and other educational technologies which support teaching and learning in the classroom.

Technology Support
Schools have access to current tools and personnel with sufficient expertise to provide ongoing support for technology in the schools.

Technical Training
Schools have sufficient training resources for the personnel who are responsible for supporting technology in the schools.

Professional Development
School teachers have sufficient opportunities to increase their skills in using technology to improve student learning.

Electronic Resources (Instructional)
School teachers use electronic products to improve student learning. Students have access to electronic products and resources that will help them meet high standards of achievement.

Electronic Resources (Administrative)
School teachers, administrators, and staff have access to electronic products and services that allow them to be more efficient and productive in their daily work.

Planning and Coordination
The State of Ohio provides leadership, coordination, and oversight in the acquisition and responsible use of technology in schools to facilitate equitable access and measurable improvement in learning.

Overall Progress

The eight SchoolNet goals reflect the key elements needed to build a high-quality physical infrastructure for delivering educational technology capabilities to each Ohio classroom, as well as the supports that are needed to encourage the growth of new practices.

Although investments have been made in each of the eight goal areas, the largest portion of resources have been directed toward building a basic infrastructure for connectivity and computer technology use. As a result, the most significant progress has occurred in these two areas, and the greatest potential for growth exists in some of the other goal areas.

Building the Infrastructure

Most of the nearly $1 billion that Ohio has invested in SchoolNet has been directed toward the process of building the infrastructure--a necessary first step. As a result of these investments, Ohio has made rapid progress in achieving its goals for network connectivity and computer technology.

Internet connectivity is now available in 88(?) percent of Ohio schools, and 78 percent (?) of Ohio classrooms.

SchoolNet Plus funding has been used to purchase multimedia computers for the state's K-4 classrooms and for all classrooms in school districts with the lowest wealth. In 1998, Market Data Retrieval's *Technology in Education* study—which is recognized as the best measurement of student access to current technology— ranked Ohio third in the country in student-to-multimedia computer ratio (1 multimedia computer per 7.4 students).

Expansion of SchoolNet Plus into fifth grade has begun. Ohio SchoolNet has prepared for this transition to the middle grades by using a five-year, $42 million federal grant from the Technology Literacy Challenge Fund to help several middle schools develop resources and field-proven technology models for middle grades.

Investments in improved connectivity and classroom technology continue:

- The ONEnet Ohio program is completing the process of linking all public K-12 classrooms to each other and the Internet.
- The Power Up for Technology program is providing about 30,000 classrooms with electrical upgrades for greater energy efficiency.
- Distance learning capabilities are expanding, largely through the Ohio SchoolNet Telecommunity, a six-year, $32 million commitment from nine major telephone companies to provide grants for integrating two-way interactive distance education capabilities into Ohio's schools.

Fostering the Growth of New Practices

Ohio's investment strategies for aiding the growth of new teaching practices have centered on professional development for teachers. SchoolNet's major activities in this goal area include:

- Developing a SchoolNet regional faculty to guide statewide professional development decisions.
- Providing Learner Profiles for grades K-12 to guide teachers as they integrate technology into the curriculum.
- Creating a teacher technology skills matrix that identifies competencies at the novice, practitioner, scholar and expert levels.
- Offering training options and resources appropriate for each level of the matrix. Over 75,000 individuals have attended SchoolNet workshops.
- Establishing demonstration sites at 15 public schools.
- Working with Ohio colleges of education and consortia from other states on projects funded by the federal Preparing Tomorrow's Teachers to Use Technology (PT3) program.

These professional development opportunities--as well as a number of online resources that can be used in improving instruction, an electronic resource to assist continuous improvement planning, and online courses and intensive workshops for district technology coordinators and administrators--are just beginning to show results in the classroom.

An Evolutionary Process

Research shows that the process of technology adoption in schools typically is an evolutionary one. Nationally recognized models of the process proposed by the Milken Exchange on Education Technology and the ten-year Apple Classroom of Tomorrow Project suggest that a transformation in teaching and learning does not immediately follow the introduction of computers into a classroom environment--even if the access, tools, training, and support provided are of the highest quality.

Teachers' initial focus is on gaining technical skills and teaching those skills to students. After this stage, they begin to integrate technology use with traditional classroom practices. For example, they might create handouts using word processing software, or they might use an electronic slideshow during a lecture instead of writing on the blackboard.

Only after they gain confidence through these activities are they ready to begin taking advantage of the power of technology.

Data from the AETA teacher survey suggest that Ohio teachers are following this pattern.

The survey listed each type of software tool available to teachers and asked them to indicate whether they use the application daily, weekly, monthly, or seldom to never.

The results--which will serve as a baseline for tracking growth in computer usage--show that the software application types with the highest usage are those that can be most easily used to support traditional teaching practices or atudent activities that are already part of most students' coursework.

For example, 53 percent of teachers who responded to the survey reported that their students use word processing on a daily or weekly basis. Word processing also was one of the more frequently listed first and second priorities for professional development.

STILL WORKING HERE

Needed Improvements

We must provide equitable connectivity and access statewide and invest greater efforts and resources in teacher learning, technology productivity, and knowledge generation.

Connectivity and Access

Network bandwidth and computer power have increased rapidly during the past five years. New software applications and upgrades to existing ones always take advantage of the latest capabilities.

Since better tools usually mean better performance for their users, periodic improvements to the educational technology infrastructure are necessary.

In addition, state and local strategies are needed for accelerating the process of providing computers, related equipment, and software at all grade levels.

Every student attending Ohio schools today needs the opportunities afforded by technology to become better prepared for success in a global, digital, knowledge-based economy and society.

Knowledge Generation

The AETA surveys provide a wealth of data, but Ohio needs additional state and local data to develop an accurate profile of how technology is being used and to evaluate the effectiveness of professional development and other support.

One area where support is needed is the development and use of accurate measures of "knowledge age" competencies, such as critical thinking, collaboration, and complex problem-solving. Only then will we be able to assess the quality of the technologies we use.

Teacher Learning

Ohio teachers encouragement to continue making progress toward a transformation in classroom practices. Professional development opportunities are need that focus on how technology integration can support a shift to approaches that are constructivist, collaborative, and interdisciplinary.

Also needed are more opportunities within school and classroom environments to pursue ongoing, job-embedded technology projects that will benefit both student and teacher learning.

Technology Productivity

Ohio schools need to encourage increased use of technology in classroom practice by removing some of the non-teaching effort involved in technology use.

Training administrators and teacher leaders in creating organizations and cultures that support new teaching methods is important. In addition, teachers need access to onsite computer specialists and support staff who can perform the technical work involved in using technoogy and help teachers solve problems and learn new skills.

Foreword:
A New Economic Landscape

During the first six decades of the 20th century, our nation's economic growth was powered by steel, coal, and manufacturing.

Ohio excelled in this industrial economy. Located in the heart of the country--crisscrossed by railroads, rivers, and highways--spacious and rich in raw materials--our state teemed with industry and commerce.

Good jobs were plentiful. Strong, hard-working Ohioans earned high wages. Our state enjoyed a competitive edge.

But today, the industrial economy that shaped 20th century Ohio has been eclipsed by a new economy that is global, digital, and knowledge-based.

The rules are changing in this new economy. Ohio's businesses must now operate on a world-wide scale and produce at an ever-increasing rate. Success will be the result of knowledge and imagination.

Furthermore, our state must now engage in what Miami University President James C. Garland calls "a new kind of struggle and economic cold war among states for a share of the global information and technology based markets."[1]

Ohio is positioning itself to succeed in those new markets through substantial investments in research, technological innovation, technology transfer, and workforce development. The capacity of our colleges and universities to produce researchers, innovators, entrepreneurs, and skilled technical workers will play a major role in the success of these investments.

But the minds and imaginations of tomorrow's skilled workers are being shaped in our K-12 schools. In the words of Norman Augustine, chair of the national Business Roundtable's Education Task Force: "More and more, we see that competition in the international marketplace is in reality a battle of the classrooms."[2]

To win this "battle," we must prepare our K-12 students for 21st century work and citizenship. ***Continued investment in technologically enriched teaching and learning for our students is a critical part of Ohio's winning strategy.***

1. Workforce Development: The Critical Challenge

The "new economy" has been defined in a variety of ways, but its essence can be expressed by three characteristics:

Global.

Goods, services, labor, innovation, and money move freely across national borders and geographical distances.

Digital.

Digital information technologies improve speed, efficiency, and cost-effectiveness in the development, production, marketing, sales, and delivery of goods and services.

Knowledge-Based.

Thinking, learning, and innovating are principal activities for creating wealth.

The U.S. businesses and industries that led the way in these three areas—competing in global markets, using digital technologies strategically, and applying knowledge in new ways—were major contributors to the long period of economic prosperity that spanned much of the 1990s. They also transformed the economies of the states and regions surrounding them, creating a new wave of job opportunities for citizens.

The next wave of economic opportunity is rapidly building.

Emerging Economic Centers

Some states—most notably California, Texas, New York, Illinois, and Massachussetts—are certain to continue prospering in the economy that their R&D institutions and businesses helped create.[3]

But with the explosive growth of information technology and new opportunities in areas such as biotechnology, advanced materials, and nanotechnology, several additional states and regions are now positioning themselves to become our nation's newest centers of high tech industry.

Ohio in Competition

Ohio is in serious technological competition for leadership in the new economy. To attract 21st century businesses and the high-wage, high-skill jobs they will create, we are strengthening our capabilities for research and development. We are forging dynamic partnerships between higher education, industry, and government. And we are creating innovative strategies for commercializing new technologies.

But achieving a competitive edge will depend upon our people.

To succeed in becoming one of our nation's future centers of economic growth, Ohio needs a workforce with the right mix of 21st century knowledge and skills:

- A strong community of knowledge generators--from biochemists to computer scientists to civil engineers.
- A steady supply of skilled technical workers--from computer programmers to automotive technicians.
- Business leaders and managers who can leverage knowledge and navigate the rapidly emerging opportunities of a new economy.
- Service providers who can instantly access, shape, and apply information and knowledge to meet a variety of customer needs.
- Health care professionals who base decisions on the most current knowledge.
- Manufacturers who take advantage of the most sophisticated tools and techniques.
- Educators who can prepare developing minds for unknown challenges.
- Community leaders who infuse politics, culture, and society with new ideas and positive solutions.

Building such a workforce is our state's most critical economic challenge.

Some of Ohio's Investments in Nurturing High Tech Industries

Ohio is positioning itself for success in the global, digital, knowledge-based economy.

Some recent initiatives for creating new opportunities to attract 21st century businesses and create high wage, high-skill jobs include:

- Recent legislation will help recruit top researchers and encourage commercialization by allowing university researchers to share in the success of their innovations.
- With the goal of expanding Ohio's research base, facilitating technology transfer, and stimulating the creation of research parks and technology incubators, Ohio's legislature has increased the state's Technology Action Fund from $3 to $30 million.
- New business tax credits for research and development and a training have been signed into law.
- Governor Bob Taft is leading the way toward a regional strategy for nurturing the high-tech industries of the future by working with the Council of Great Lakes' Governors to form the Great Lakes Biomedicine/Biotechnology Consortium.

Ohio also is working to meet the skill demands of high tech industries by:

- Tripling funding for its Jobs Challenge initiative to enable two-year colleges to provide customized non-degree training to employers.
- Working to raise the number of high school students preparing for technology-based careers. Governor Taft's goal is 35,000 students in Tech Prep programs by 2003.
- Developing a comprehensive workforce strategy with guidance from a 57-member Workforce Policy Board that includes several representatives from the business community.[4]

Source: Governor Bob Taft, *The Year in Review*, 1999

Ohio's Key Long-Term Strategy

In the new economy, which is shifting toward high-skill, high-wage jobs, Ohio needs a comprehensive approach to workforce development that encompasses both short- and long-term strategies.

Our most important long-term strategy is creating a K-16 educational system that prepares all Ohio students for success in a new economy and a rapidly changing world.

Beginning in the early grades, Ohio students need to think, learn, and work in ways that reflect the challenges they will face as adults in the new economy:

- They need good textbooks. But they also need to witness ideas circling the globe at the speed of light, the complexities of a global community, and the achievements of their future competitors—students in other nations.
- They need to gain the basic skills that provide a foundation for all learning. But they also need to experience the use of 21st century methods and tools for finding information, solving problems, and communicating.
- They need to acquire a body of knowledge. But they also need to develop minds that can put existing knowledge to work in a variety of contexts—and generate new knowledge, ideas, and solutions.

In short, building a future workforce that will give our state a competitive edge in the new economy means creating global, digital, knowledge-based schools for all Ohio students.

Ohio SchoolNet

Ohio has already laid the foundation for global, digital, knowledge-based schools through the work of Ohio SchoolNet.

Since Ohio SchoolNet was established in 1994, our state has made significant progress in creating a basic physical infrastructure for educational technology.

The majority of our classrooms have been wired for the Internet. A high percentage of our K-4 classrooms have been equipped with at least one multimedia computer, and fifth-grade classrooms are beginning to be funded. Districts also have used local funding—and in some cases, funding from the business community—to purchase technology for their schools.

With the physical infrastructure for educational technology well-established, it is time for Ohio to begin the transition to global, digital, knowledge-based schools.

SchoolNet's Accomplishments

Launched in 1994 by Governor George V. Voinovich and the Ohio General Assembly, Ohio SchoolNet represented a commitment to wire all of Ohio's public school classrooms for voice, video, and data, as well to provide computers to every classroom in the 25 percent of districts with the lowest-wealth.

Following the original $95 million investment, the legislature established SchoolNet Plus in 1995 to provide $400 million in funding for the purchase of multi-media computers for the state's K-4 public school classrooms.

As a result of these investments:

- 88 percent of Ohio's schools now have access to the Internet.
- 78 percent have Internet access from one or more classrooms
- Ohio's overall ratio of one multimedia computer for every seven students was ranked third in the nation in 1998.[5]

Ohio Schools in Transition

As we count the costs of installing computers and Internet connections in our schools, it is natural to begin looking for immediate improvements in student learning.

But delays are almost inevitable when new technologies are introduced.

In fact, various groups, including researchers with the Apple Classroom of Tomorrow (ACOT) study,[6] the CEO Forum,[7] and the Milken Exchange on Educational Technology,[8] have outlined distinct stages of progress.

During the initial stages, learning environments and teaching and learning practices remain relatively unchanged. Then a transition begins. Teachers start developing their technology skills and integrate technology into existing practices. They become more confident with their technology use.

Finally, comes a transformation stage in which technology is used for teaching, learning, and interacting in ways that have never before been tried. It is in this final stage of transformation that schools become global, digital, knowledge-based learning environments.

Only in the transformation stage will students engage in new work and learning habits and teachers exhibit new roles and practices.

Educational technology initiatives in most Ohio schools are now in transition--the middle period of integration and adaptation.

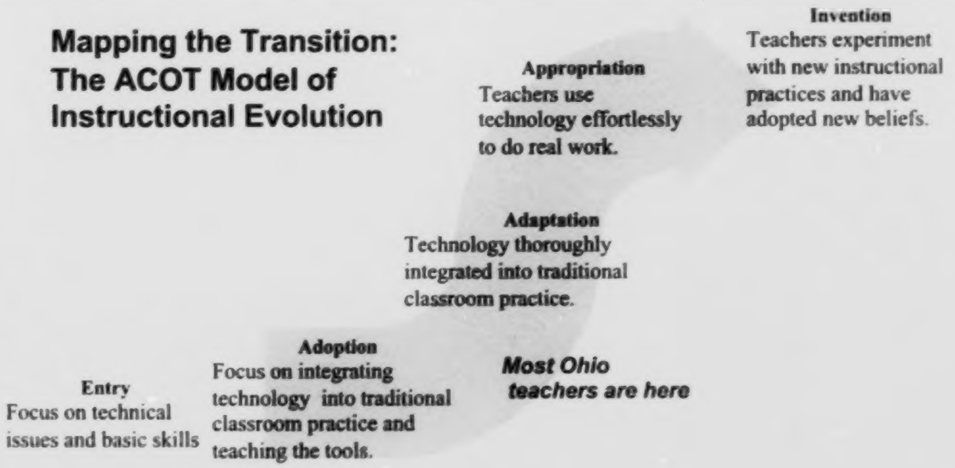
Technologies are in place. Many teachers have learned basic skills and taken steps to incorporate the new technologies into their teaching.

But most Ohio teachers are not yet using educational technology as a tool for interacting with their students in new ways, changing practices that are ineffective, and developing innovative, student-focused learning experiences.

We must accelerate our progress toward global, digital, knowledge-based Ohio schools that prepare all students for the new economy. We can do this by investing our efforts and resources in teacher learning, technology productivity, and knowledge generation.

The economic benefit of these steps will be the creation of the global, digital, knowledge-based schools needed in a new economy and a changing world.

Mapping the Transition: The ACOT Model of Instructional Evolution



Invention
Teachers experiment with new instructional practices and have adopted new beliefs.

Appropriation
Teachers use technology effortlessly to do real work.

Adaptation
Technology thoroughly integrated into traditional classroom practice.

Adoption
Focus on integrating technology into traditional classroom practice and teaching the tools.

Entry
Focus on technical issues and basic skills

Most Ohio teachers are here

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2. Global, Digital, Knowledge-Based Schools: The Economic Advantages

When viewed from an economic perspective, continued investments in the technological enrichment of teaching and learning offers some distinct advantages:

A global perspective. Our schools will expose students to the global community, promote high standards, and help diminish the inequities and barriers that often keep low-income and under-represented groups out of the skilled workforce.

Students prepared for the digital world. Our schools will narrow the gap between real world expectations for technological proficiency and students' educational experiences.

Students prepared for knowledge work. Our schools will expand opportunities for developing the habits and abilities of critical thinking, problem-solving, communicating, and lifelong learning that are essential for performing knowledge work.

Developing a Global Perspective

To prepare students for success in the new economy, the K-12 educational community and itsstudents need to develop a global perspective.

Preparing Students for Global Organizations

Today's K-12 students will work in environments that require a global perspective:

- Many will work for companies that serve international markets. Their success will depend largely on their ability to anticipate and respond to the needs of customers in other nations.
- Many will work on projects with colleagues from around the world. Their success will depend largely on their ability to collaborate and to understand and appreciate other cultures.
- Many will have jobs that require meeting competing demands. Their success will depend largely on their ability to see the big picture, to look at problems from all angles.

Real opportunities to develop each of these abilities are more easily available in technologically enriched teaching and learning environments.

Meeting Global Standards

Discussions of educational improvement often center on developing standards to ensure that U.S. curricula are designed to produce students who can compete with their counterparts in a global economy. Many of our nation's governors and business leaders have long supported national standards.

When U.S. eighth- and twelfth-graders performed at or below the international averages on the Third International Mathematics and Science Study (TIMSS), the National Science Board strongly recommended that educational systems across the nation come to consensus on a common core of knowledge and skills in mathematics and science to be embedded consistently in classroom teaching and learning.[9]

The nationwide—even worldwide—sharing of ideas and information that is a necessary first step to this consensus process can be much more dynamic among technologically enriched teaching and learning environments.

Teachers with access to the Web can instantly download the standards proposed by the National Council of Teachers of Mathematics,[10] the American Association for the Advancement of Science,[11] the National Research Council and National Academy of Sciences,[12] and the National Educational Technology Standards.[13]

Taking advantage of the opportunity to read such resources and communicate with the best teachers and education systems in the world—perhaps even to watch demonstrations of best practices—will encourage more thinking about what standards represent "best in the world."

With this trype of perspective, Ohio schools will raise the bar. Rather than comparing their proficiency test results with those of similar school districts, educators with a global perspective would be examining best practices worldwide. Achieving an Effective rating on the annual district report card would be viewed as only the first step in achieving excellence. Our state's minimum performance standards would be replaced by world class benchmarks.

Closing the Digital Divide

Providing equitable opportunities to achieve also is essential in developing schools and students with a global perspective.

In 1995, Ohio's legislators advanced educational equity by providing every classroom in the state's lowest wealth districts with funding for computers.

In the years since that decision, the rest of the nation has become increasingly aware of a growing "digital divide."

According to the U.S. Department of Commerce, high-income households in the U.S. are twenty times as likely to be connected to the Internet as households at the lowest income level are. Black and Hispanic households are about two-fifths as likely to have home Internet access as white households, and those in rural areas lag behind those in urban areas." [14]

If this trend continues, we will eventually live in what Don Tapscott calls a society of "information haves and have-nots, knowers and know-nots, doers and do-nots."[15]

The consequences of the digital divide will be severe for the "have-nots." According to Patricia Dung, Science Director of the Los Angeles Educational Partnership, "lack of access to technology can result in both lower academic achievement and lower job expectations. It can be the gatekeeper of the future."[16]

Eliminating Inequities in Instruction

Nationally, Black and Hispanic students in low-wealth schools are in the greatest danger of becoming tomorrow's "information have-nots." They have less access to educational technology than do students in wealthy communities.

Furthermore, their experiences with technology are of a lower quality than are those of students in wealthy communities, according to Harold Weglinsky of the Policy Information Center, Education Testing Service.[17]

In his analysis of how technology impacted student performance on the National Assessment of Educational Progress (NAEP), Wenglinsky observed lower performance among eighth-graders who used computers primarily for drill and practice and higher performance among those who used computers for simulation and application.

He also found that black and Hispanic eighth-graders were significantly less likely than their white counterparts to use computers for the more sophisticated functions of simulation and application but were more likely to employ computers for drill and practice.

Averting a Shortage of High Tech Workers

To compete globally, many of Ohio's high tech companies must now depend upon foreign workers who obtain visas under the H-1B non-immigrant category of U.S. immigration law.

But as evidenced by the current world wide shortage of information technology workers, this strategy has limited value.

In the long term, it is also risky.

As more nations begin to compete in the new economy, they will create more high-wage job opportunities to offer to their skilled workers, including those who pursue advanced study in the United States. As more U.S.-educated workers carry technical expertise back to their native countries, higher education in those countries will improve—further diminishing the role of our universities as sources of high tech knowledge workers.

With these potential risks to the future competitiveness of Ohio's high- tech industries, Ohio must do more to develop the technical skills of students in its low-wealth schools. They are a largely untapped resource with great promise.

Serving Disadvantaged Communities

In addition to preparing disadvantaged students for workplace technology and knowledge work, technology in low-wealth schools also will help remove some of the other disadvantages that can impede their success—such as the low educational levels and unemployment of their parents.

According to the U.S. Department of Commerce, "groups that are less likely to have Internet access at home or work (such as certain minorities, those with lower incomes, those with lower education levels, and the unemployed) tend to access the Internet at schools and public libraries. These same groups also tend to engage in online activities that can result in their economic advancement, such as taking educational courses, engaging in school research, or conducting job searches." [18]

Expanding Options

Providing low-wealth schools with what Andrew Blau calls "the basic tools of opportunity, of wealth creation, of political engagement"[19] not only will help close the digital divide, it will also help solve some of the other problems facing students in low-wealth schools.

Engaging Under-Motivated Students

According to a 1997 study by the Corporation for Public Broadcasting, 82 percent of teachers surveyed believed that multimedia computer activities lead to increased student motivation and enthusiasm for learning.

The same benefits were attributed to online activities by 76 percent.[20]

Other studies have provided some affirmation for this belief:

- According to the U.S. Department of Education, "technology-rich schools report higher attendance rates and lower dropout rates than in the past." [21]
- A report on data collected between 1990 and 1994 by the Software Publishers Association cites several studies that link technology-rich environments to consistent improvements in "student attitudes toward learning and student self-concept."[22]
- A 1996 review by RAND of numerous studies also linked educational technology to improved motivation.[23]

Mitigating Impacts of Teacher Shortages.

According to the National Center for Education Statistics, our nation's schools will need to hire approximately 2.4 million teachers over the next 11 years because of teacher attrition and retirement and increased student enrollment.[24]

Low-wealth schools, already struggling to recruit and keep good teachers, are certain to be the most severely affected.

Although computers should not be considered a replacement for good teachers in low-wealth schools, they can help mitigate the effects of teacher shortages. For example, John Goodlad's suggestion to enlist highly educated, experienced teachers to lead teams of new teachers[25] could be more effectively employed if teams were linked electronically.

Expanding Access to Opportunities

Schools in our low-wealth districts are working toward better teachers and learning opportunities for their students. Increasing the graduation rate and college participation is critical.

Technologically enriched learning environments in our low-wealth schools would provide opportunities for students to:

- Gain access to advanced courses through distance learning.
- Spend some time interacting with telementors who could guide their learning.
- Attend virtual summer school or Saturday sessions to receive extra help.

Preparing Students for a Digital World

Our students are entering a digital economy in which nearly all but the lowest paying jobs will require at least a basic foundation of knowledge and skill in using sophisticated information technology. In addition, a large percentage of jobs will require significantly more than basic technology skills, and some of the most promising, highly paid jobs will require technology expertise.

Jobs of the Future

Many of the new professional and skilled jobs have been created in industries that produce information technologies or use them in innovative ways. In fact, the U.S. Department of Commerce estimates that in five years, almost half of all workers will be employed in industries that produce or intensively use information technology.[26] The remaining half will require varying degrees of proficiency with information technology, but less than 20 percent of all jobs will be low-skill (and those will be mostly low-paying).[27]

IT Industries

IT-producing industries—which employ a large core of computer scientists, computer engineers, systems analysts, and computer programmers—currently pay the highest salaries. The average annual wage for workers in IT-producing industries was $58,000 in 1998—or 85 percent higher than the $31,400 average wage for all private workers.[28]

According to the U.S. Department of Commerce, IT-producing industries accounted for only 8.3 percent of the economy's total output in 2000. But they contributed nearly a third of real U.S. economic growth between 1995 and 1999 by enabling the transformation of industries that the U.S. Department of Commerce refers to as IT-using.[29]

IT-Producing Industries: A Key Economic Engine

The IT-producing industries are high-tech enterprises that supply hardware, software, and networking products and services. Several sources indicate that employment growth in the IT industries is outpacing average employment growth:

- According to the U.S. Department of Commerce, employment in the IT industry grew almost 28 percent from 1994 to 1998, and employment in IT occupations increased by 22 percent over the same period. By contrast, over those same years, total U.S. nonfarm employment rose by about 11 percent.[30]
- According to a report by the Information Technology Association of America (ITAA), employers are expected to create a demand for roughly 1.6 million IT workers just in the year 2000.[31]
- The Bureau of Labor Statistics (BLS) projects that IT-producing industries will employ almost six million workers

IT Job Growth in for Ohio

In the 10-year period between 1996 and 2006, Ohio's projected job growth in the computer and data processing services industries is expected to increase by 88 percent (from 43,000 jobs in 1996 to 81,000.[33] Rising demands for skilled IT workers in all industries include:

Computer engineers	+103%
Computer systems analysts	+94%
Database administrators	+73%
Computer support specialists	+74%
Data processing equipment repairers	+42%
Computer programmers	+19%

Source: Ohio Bureau of Employment Services

IT-using industries—those that are among the top fifteen industries in relation to either IT investment per employee or the percentage of their total equipment stock that is IT equipment—are a vital part of the employment picture. According to the U.S. Department of Commerce, the IT-using industries:

- Accounted for between 40 and 50 percent of annual employment growth between 1992 and 1997.
- Employed almost 43 million workers in 1997 and paid an average wage that was 12.6 percent higher than the average for all industries ($33,500).
- Will constitute 44 percent of the nation's private workforce and employ 51 million workers by 2006.[34]

Ohio will experience significant job growth in some of the 15 occupations that require intensive use of information technology. Finance, insurance, and real estate occupations will grow by 33 percent. Health occupations will account for approximately one in seven new jobs for Ohioans with the largest growth (22 percent) among health technicians.[35]

Industries Considered Major Users of IT Equipment

- Telecommunications
- Security and commodity brokers
- Radio and TV broadcasting
- Business services
- Other services, not elsewhere classified
- Health services
- Motion pictures
- Holding and investment offices
- Legal services
- Wholesale trade
- Insurance carriers
- Real estate
- Instruments and related products
- Insurance agents and brokers
- Depository institutions
- Nondepository institutions
- Pipelines, except natural gas
- Petroleum and coal products
- Chemicals and allied products
- Electronic equipment

Source: U.S. Department of Commerce[36]

Ohio's Progress in High-Tech

Ohio's high-tech payroll for 1999 was $6.5 billion for 5,900 high-tech establishments. It's technology industry paid an average wage of $46,800, or 55 percent more than the average private sector wage.

Nationally, Ohio ranks:

- 5th in industrial electronics manufacturing employment with 14,200 jobs
- 8th in communications equipment manufacturing employment with 8,600 jobs
- 9th in data processing and information services employment with 14,200 jobs
- 10th in computers and office equipment manufacturing with 8,600 jobs

Source: American Electronics Association[37]

Other High-Tech Jobs

It would be inaccurate to say that the remaining 51 percent of jobs remain outside of the digital, knowledge-based economy. Many future jobs that are classified as "non-IT" according to the U.S. Department of Commerce's definition will be highly technical in nature. Such jobs include:

- Highly trained scientists and engineers in specialized non-IT areas, such as environmental engineering, aerospace, and biotechnology.
- Technicians and technologists who install, diagnose, operate, and repair equipment in areas ranging from aircraft maintenance to manufacturing to auto repair.
- Systems analysts and computer programmers employed by large retail and restaurant chains, airlines, universities, and government agencies to design and maintain corporate information systems and networks.

In addition, the rise in e-commerce--expected to represent an annual dollar value of between $634 billion and $2.8 trillion by 2003[38]--is likely to increase skill requirements for many of the low-skill sales and customer service jobs of today and make business ownership a possibility for more young people.

Growth in telecommuting and virtual work groups—viable alternatives for those who are sufficiently comfortable with technology—could alleviate a significant portion of today's child care problems, as well as allowing workers to "relocate" to new jobs without uprooting their families.

Business Basics

Since most industries have become centered on information, even many skilled jobs that are not considered "high-tech" will require more technology proficiency than the average worker has today.

Workers who are striving to advance in any business setting will be expected at some time to do several of the following:

- Create documents, presentations, spreadsheets, and databases using desktop software applications.
- Use e-mail systems to communicate internally and with customers and suppliers.
- Use electronic systems to enter and access data used for accounting, budgeting, scheduling, project management, inventory control, and other corporate functions.
- Access job-specific information through libraries of product information that have been placed on intranets.
- Upgrade their skills through customized computer-based training courses or commercially available tutorial software.

These basic skills are largely lacking among today's job applicants—even those with college degrees.

To illustrate: twenty-five colleges and universities in Virginia and Maryland have piloted Tek.Xam, a five-hour computerized test used to determine the basic technology skills of job candidates with non-technical degrees. The pass rate has been about 30 percent.[39]

Early Preparation for Technology in the Workplace

The educational requirements of today's most promising and plentiful jobs vary. But whether a student ultimately chooses to pursue an advanced degree in computer science, a bachelor's degree in education, an associate's degree in graphic arts, or a certificate in auto repair, the same conclusion is valid:

Becoming a fluent user of information technology is now as basic as reading, writing, and mathematics.

An elementary school student who learns to use a keyboard or mouse with dexterity, a middle school student who becomes skilled with Internet search engines, and a high school student who successfully creates a Web page are all building a foundation of technical proficiency that will be widely useful whatever their career choices.

In addition, activities such as choosing the technological tools that will achieve desired results, using knowledge of one software application to learn others, and engaging in everyday troubleshooting require the use of "metacognition."

Described by the National Research Council as a process of monitoring one's own learning, metacognition involves employing strategies such as "predicting outcomes, planning ahead, apportioning one's time, explaining to one's self in order to improve understanding, noting failures to comprehend, and activating background knowledge."[40]

Using a software application to do work requires all of these metacognitive strategies.

So while the specific tools used in today's classrooms may be obsolete by the time students enter the workplace, routine use of computers in the classroom can develop metacognitive skills and strategies that will bring lifelong benefits.

Preparing Students for Knowledge Work

Most of today's students will be working in jobs that require them, to some degree, to become knowledge workers.

The primary work of some will be transforming knowledge into new forms by creating games, art, music, and other electronic content. For others—teachers, public relations and advertising workers, and journalists—it will be sharing knowledge. Some will convert knowledge into software or build it into product designs. Others will manage the knowledge of corporations or work groups.

Their workplaces, says Don Tapscott, will be settings where "motivated, self-learning, entrepreneurial workers empowered by and collaborating through new tools apply their knowledge and creativity to create value."[41]

Knowledge Work Competencies

The Secretary's Commission on Achieving Needed Skills (SCANS) outlined five essential workplace competencies tthat are needed for solid job performance.

According to SCANS, **effective workers can productively use**:

Resources- They know how to allocate time, money, materials, space, and staff.

Interpersonal skills- They can work on teams, teach others, serve customers, lead, negotiate, and work well with people from culturally diverse backgrounds.

Information- They can acquire and evaluate data, organize and maintain files, interpret and communicate, and use computers to process information.

Systems- They understand social, organizational, and technological systems; they can monitor and correct performance; and they can design or improve systems.

Technology- They can select equipment and maintain and troubleshoot equipment.

Source: *What Work Requires of Schools: A SCANS Report for America 2000.*[42]

The Role of Technology in Creating Knowledge-Based Schools

In classrooms that provide the "new tools" of knowledge work, teachers will have more options for creating learning experiences that reflect the challenges of knowledge work.

Creating a Knowledge Work Context

In knowledge-based schools, students work in contexts that resemble real world problems. Computer simulation tools help teachers create these contexts.

The benefits of simulation tools can be seen in a study of the NAEP results by the Educational Testing Service (1998). According to ETS, eighth graders whose teachers used computers mostly for 'simulations and applications' performed better than students whose teachers did not.[43]

Lewis Perelman also advocates the use of simulation tools. He cites research findings indicating that general concepts and knowledge learned in school do not transfer to everyday practice,[44] that life experience does not help in solving classroom problems,[45] and that knowledge gained in one school subject does not transfer to others.[46] Perelman says the answer lies in "bringing learning as close to the real context of practice as possible."[47]

Using simulation technologies and design software also creates instructional opportunities not otherwise available. Many problems in science, social studies, and the arts can be solved only through inquiry, experimentation, and performance—processes that often require too much time, space, and money to be feasible. However, technology makes these powerful ways of learning manageable.

Improving Communication and Collaboration

Collaboration—across the boundaries of disciplines, organizations, and nations—are becoming increasingly common in knowledge-based organizations.

Mary L. McNabb of the North Central Regional Educational Laboratory describes the potential for technology to create similar "collaborative communities" within the classroom. "With advances in telecommunications networks," says McNabb, "the 'classroom' may expand beyond the walls of the school building to cyberspace where telementoring relationships among learners and more knowledgeable others can develop and flourish."[48]

Such collaborative communities not only enrich the curriculum, they also improve students' communications skills.

Numerous studies have demonstrated the value of technology in improving student writing. According to a 1996 U.S. Department of Education report, students are more willing to edit their work when using word processors and more comfortable with critiquing and editing the work of others when it is exchanged over a computer network.[49]

Eight years of research on the effects of Maureen Scardamalia and Carl Bereiter's Computer Supported Intentional Learning Environment, a widely studied software application for sharing ideas in a collaborative setting, found that students who used the tool showed greater depth of understanding and reflection, as well as improved scores on standardized reading, language and vocabulary tests.[50]

Helping Students Learning How to Learn

In recent years, Jeffrey D. Rice, Associate to the Dean at the Ohio State University's Fisher College of Business, has seen a major shift in recruiting:

"Employers are no longer concentrating on one specific skill an employee brings to an organization," says Rice, "but rather that employee's ability to increase his or her knowledge and skills quickly in relation to advances in technology and market direction. Undoubtedly, adaptability and short learning curves are two of the knowledge economy's most critical literacies.[51]

Thomas G. Layton, originator of the nation's first distance learning high school, agrees. He reminds us that many of today's children will work in jobs that do not yet exist and even be required to unlearn some of what they are learning now.

When today's students enter the workforce, says Layton, they will need the ability to "gather knowledge, make use of it, let go of knowledge that is of little use, and then learn new and relevant things."[52]

A 1997 report to the President from the Panel on Educational Technology says that a shift to a "constructivist learning paradigm" has been tied to the nation's requirement for 21st century workers with "the capacity to readily acquire new knowledge, to solve new problems, and to employ creativity and critical thinking in the design of new approaches to existing problems." [53]

Thinking Skills for Workplace Success

According to the U.S. Department of Labor, the foundation for developing workplace competencies consists of basic skills, personal qualities, and thinking skills, including thinking creatively, making decisions, solving problems, visualizing, knowing how to learn, and reasoning.

- Creative thinking - generates new ideas
- Decision making - specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternatives
- Problem solving - recognizes problems and devises and implements plan of action
- Visualizing - organizes and processes symbols
- Knowing how to learn - uses efficient learning techniques to acquire and apply new knowledge and skills
- Reasoning - discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem

Source: *What Work Requires of Schools: A SCANS Report for America 2000.*[54]

The report says that technology can aid the shift to constructivist learning, which David Perkins of the Harvard Graduate School of Education has linked to "better retention, understanding, and active use of knowledge."[55]

One reason technology is so effective for active, independent learning is its ability to provide "cognitive scaffolds." In *How People Learn*, the National Research Council compares computers to training wheels on a bicycle.

"Computer scaffolding," says the NRC, "enables learners to do more advanced activities and to engage in more advanced thinking and problems solving than they could without such help."[56]

Few schools have gained extensive experience in using computer scaffolding, collaborative software environments, simulations, and other technology-enriched teaching and learning practices. Those that have, however, have demonstrated that technology can support improved student achievement.

In fact, authors of a study by RAND say that the challenging standards of the today's school reform agenda "may not be achievable without the use of technology" to support new practices. Examples of the practices outlined in the study include those that "tailor learning experiences more clearly to learner needs and abilities, provide students with access to resources and expertise outside the school, support more authentic assessment of a student's progress, and manage and guide the learning activities of the students."[57]

Much remains to be learned, and many other educational reforms need to occur before technology will make a real difference.

But in our new economy, lifelong learning is critical for career success, and technology is a vehicle for learning anytime, anywhere. To remain relevant, schools must be the best models for this revolution in learning.

3. The Transition to Global, Digital, Knowledge-Based Schools: The Next Step

Ohio has the technological capacity to create the types of teaching and learning environments that would help develop the global perspective, technological fluency, and adaptive, lifelong learning abilities needed in a new economy.

The time has come to begin taking full advantage of that capacity.

Because of the complexity and expense of creating the necessary physical infrastructure of network connections and computers, Ohio's investments and efforts during the "entry stage" of technology adoption had to be focused on the *tools* more than on the desired *educational improvements*.

Today, the tools are in place in most of Ohio's elementary schools. A large percentage of teachers have acquired the basic technical skills for using those tools. Many have adopted technology as a way to improve their success with traditional teaching methods, as well as to increase efficiency and motivate students.

It is time to shift our primary emphasis toward teaching and learning.

Ohio needs to accelerate its progress in creating the global, digital, knowledge-based schools that are needed to prepare all students for a new economy and a changing world.

We must provide equitable connectivity and access statewide and invest greater efforts and resources in teacher learning, technology productivity, and knowledge generation.

1. *Provide equitable connectivity and access statewide.*

Ohio's original plan for SchoolNet funding was to focus initially on placing technology in K-4 classrooms and in all classrooms in 25% of districts with the lowest wealth—then to add one grade per year.

SchoolNet funding has now been extended to fifth grade and many districts have used funding from local sources, federal grants, and business to provide at least basic equipment to their middle and high schools.

The ONEnet Ohio program is ensuring that we finish wiring and connecting our schools, and the Power Up for Technology program has begun providing needed electrical upgrades for nearly 30,000 Ohio schools.

Distance learning capabilities also are evolving—first through the Ohio SchoolNet Telecommunity, made possible by a $32 million commitment shared by nine major telephone companies and later through a new Interactive Video Distance Learning Pilot.

However, some gaps in connectivity and access remain. Many schools still have an insufficient number of computers. Many of our middle schools and high schools have outdated computers that are incapable of running multimedia applications or accessing the Web. We must do better. The shift to skilled jobs has already begun, and every student attending Ohio schools today will be competing in the global, digital, knowledge-based economy.

We must continue improving our ratio of students to multimedia computers—particularly in our middle schools and high schools.

2. *Invest in knowledge generation*

Educational technology will always be part of a total educational reform package. Because its effects are not easily isolated and measured, it is difficult for even a single school building to attribute either failures or successes to the use of technology. From a statewide perspective—which must take into account myriad variations in the methods and environments surrounding the use of technological tools—it is even more difficult to determine whether technology is making any difference.

However, Ohio has expanded its knowledge base considerably.

This year's Annual Educational Technology Assessment (AETA)—conducted at the teacher, building, and district levels—has provided a wealth of data for targeting state and local investments. The high return rate for the surveys—90 percent of teachers, x buildings, and 90 percent of districts—means high confidence that the results are representative.[58]

Based on AETA results, research questions are being formulated to ensure a more in-depth picture of educational technology and its uses in Ohio schools.

Such inquiry is essential for planning and decision-making. But we must also begin to broaden our research perspective beyond looking at proficiency test performance and develop additional measures for evaluating the effects of technology.

Studies of technology usage have found some improvements in basic skills and standardized test scores.[59] More documentation of such results is needed. However, technologically enriched learning environments are more suited to developing competencies that are not accurately measured by proficiency tests--competencies such as complex problem-solving, critical thinking, collaboration, and creativity.

We must support the development and use of accurate measures based on these competencies and encourage Ohio teachers to use these measures. Only then will we be able to assess the quality of the technologies we use.

We owe our students who have already mastered the skills measured by the proficiency tests the best opportunities for developing more advanced competencies. We owe our students who are having difficulty mastering basic skills the benefits of the best tools for differentiating instruction.

3. *Support teacher learning*

Based on the results of SchoolNet's Annual Educational Technology Assessment (AETA), most Ohio teachers are using technology in a limited fashion.

Applications used most often with students are those that can be easily adapted to traditional instruction, such as word processing, commercially developed curriculum software, and content-specific drill and practice software.

Most of the 90,000 plus Ohio teachers who responded to the survey reported that in their classrooms,Web search engines are used once a month or less often. Few are using multimedia applications and equipment. Most science classes are not using probeware and simulations, and most mathematics classes are not using spreadsheets. A number of software applications are seldom or never used by the majority of teachers, and the demand for training in these applications is low.

The most powerful way to encourage more extensive adoption of technology and greater innovation in how it is used is through effective professional development.

AETA data suggest that teachers are not devoting sufficient time to professional development activities. Only 23 percent of AETA respondents have participated in more than 15 hours of technology training since Fall 1998, and 38 percent have participated in less than five hours.

Although Ohio teachers have many avenues for training available, enrollment patterns for the four levels of training offered by SchoolNet suggest that many teachers may be pursuing only basic skills training.

According to the ACOT study, as teachers sharpen their technical skills, they should begin seeking increasingly individualized professional development opportunities that will enable them to tie the use of technology to standards and to employ principles of constructivist, cooperative, and multidisciplinary teaching and learning.[60] This often means developing their own followup activities after they attend training, as well as pursuing study groups, mentoring arrangements, and long-term research and design projects within their own classrooms.

As Ohio's Local Professional Development Advisory Committee points out, quality professional development approaches such as these require system support and strong leadership.[61]

In short, creating the global, digital, knowledge-based schools needed in the new economy, Ohio schools must provide teachers with the time and resources needed to engage in ongoing, job-embedded, project-based learning focused on the innovative use of technology in teaching and learning.

4. Improve Technology Productivity

Marketing research by the computer industry, conducted during the early 1990s, indicates that less than 3 percent of the population was willing to experiment, take risks, and learn independently when presented with the opportunity to use computers. Less than 15 percent was willing to try new things or go out of their way to learn computer skills. Most are slow to change and will do so only under competitive or social pressure or after others have survived the risks and are reaping the benefits.[62]

Although computers are no longer considered new, teaching with computer simulations, designing online courses, and other innovative classroom uses of computers are still relatively unknown territory.

Training will help teachers enter and master this new territory, but additional motivation is needed.

According to the ACOT study, a major turning point in a teacher's use of educational technology is when he or she begins to use technology effortlessly to accomplish real work. In a sense, when teacher reach this point, technology becomes "invisible."[63]

The technology is hardly invisible when a teacher has to set up equipment, learn the intricacies of several software applications, deal with compatibility issues, find ways to allocate computers, and deal with computer crashes and network outages at crucial points in a lesson. Too many of such experiences discourage frequent use of technology.

Investments that will remove some of the effort of technology use for teachers include training administrators and teacher leaders in creating organizations and cultures that support new teaching methods and increasing the number of computer specialists and support staff working in schools.

Notes

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Educational Technology Evaluation Project

Steve Cowdrey
Director of Technology
Cherry Creek Schools

10/18/00

Click here to start

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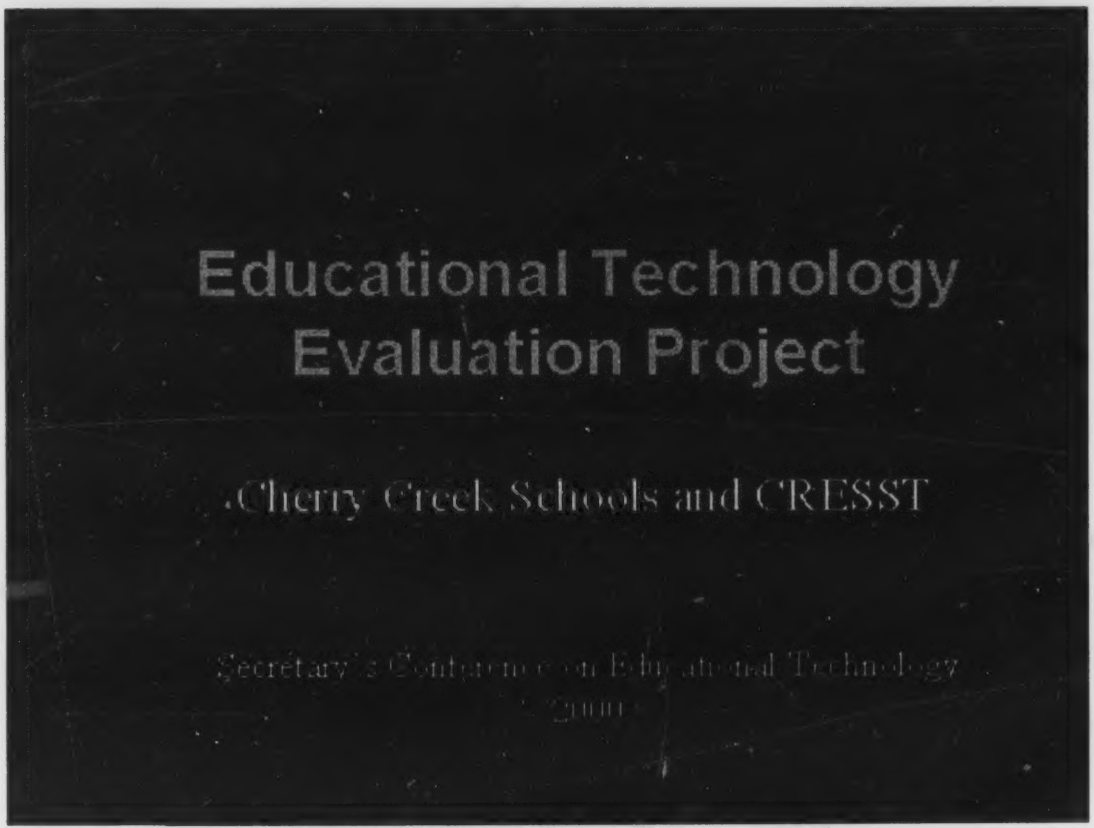

Educational Technology Evaluation Project

Cherry Creek Schools and CRESST

Secretary's Conference on Educational Technology 2000

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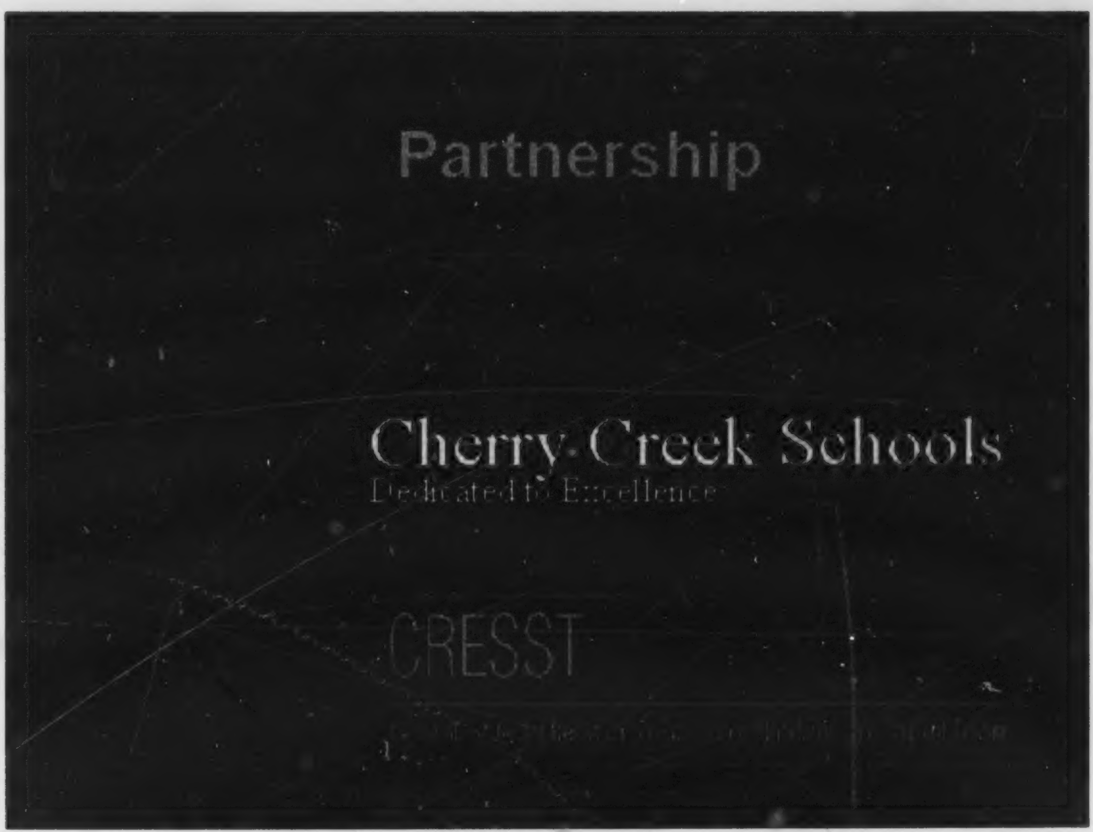

Partnership

Cherry Creek Schools
Dedicated to Excellence

CRESST

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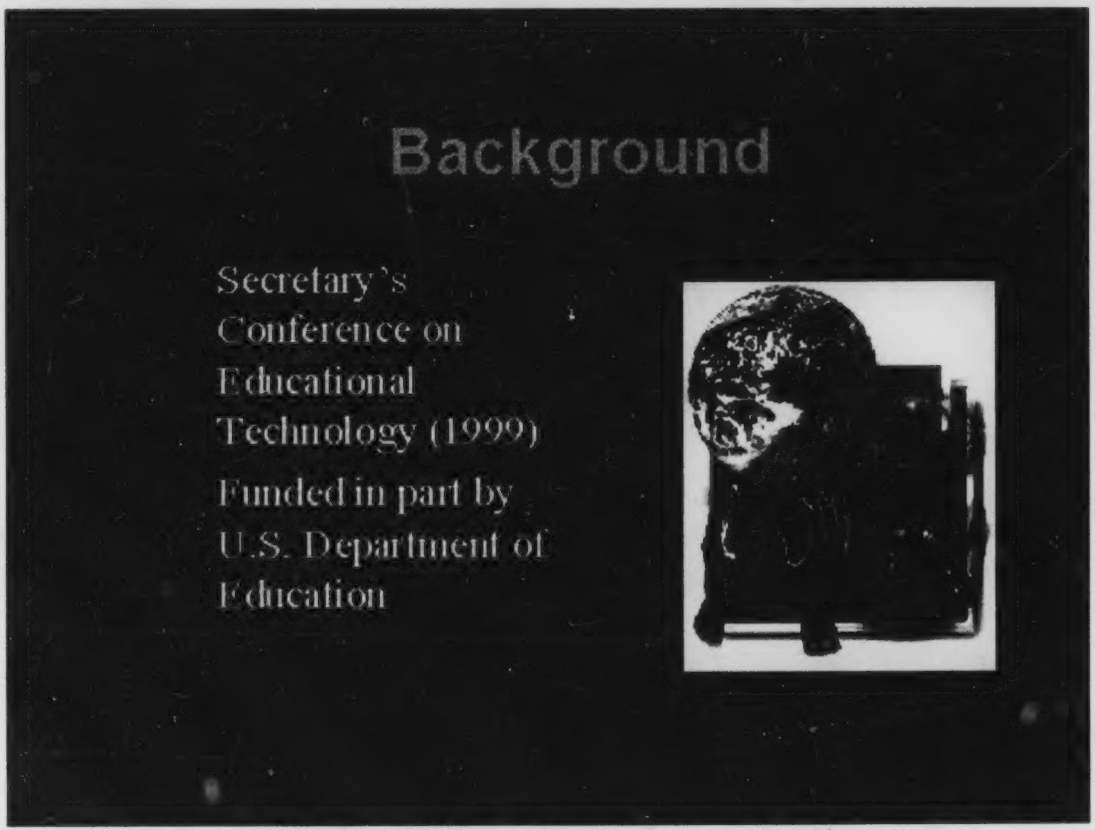

Background

Secretary's Conference on Educational Technology (1999)

Funded in part by U.S. Department of Education

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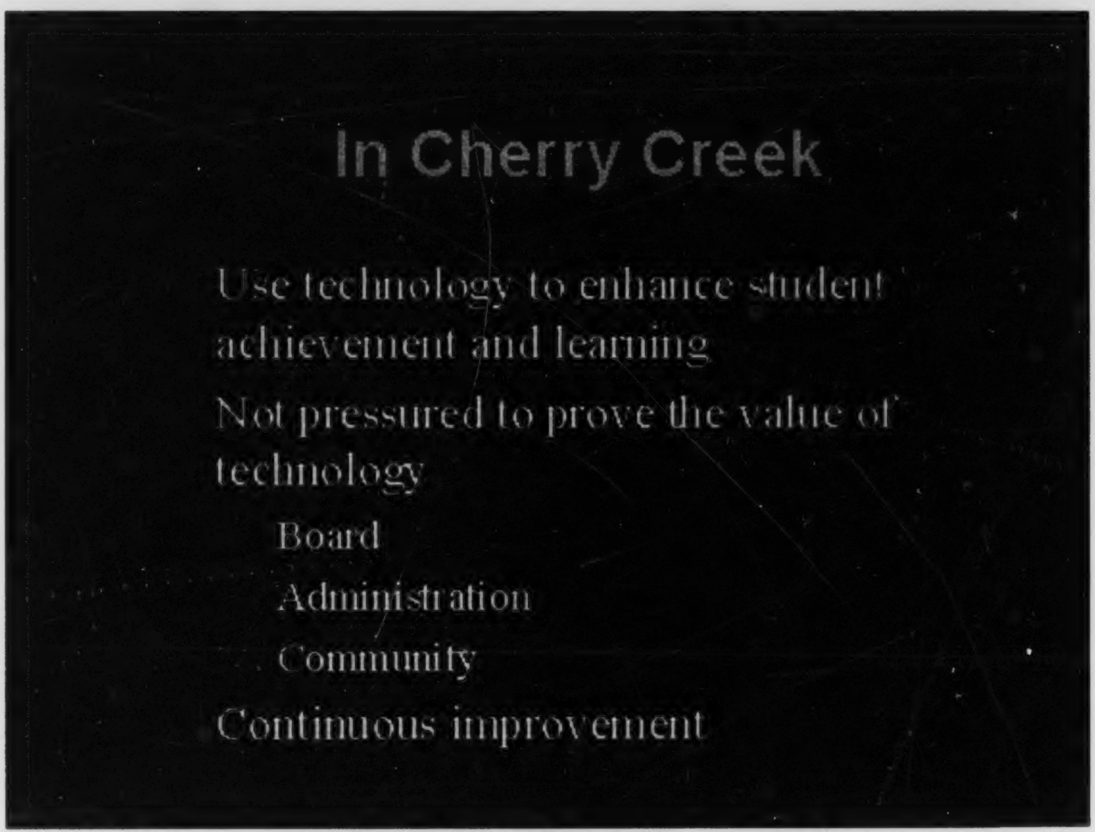

In Cherry Creek

- Use technology to enhance student achievement and learning
- Not pressured to prove the value of technology
  - Board
  - Administration
  - Community
- Continuous improvement

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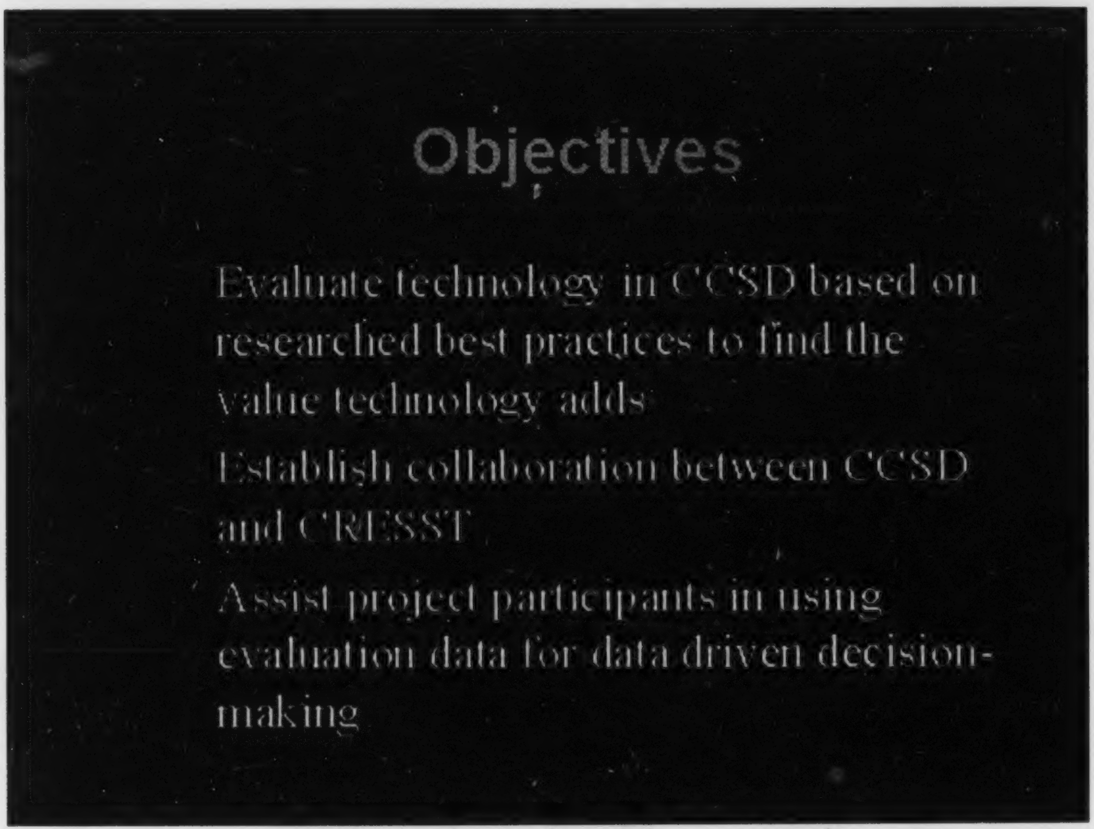

Objectives

- Evaluate technology in CCSD based on researched best practices to find the value technology adds
- Establish collaboration between CCSD and CRESST
- Assist project participants in using evaluation data for data driven decision-making

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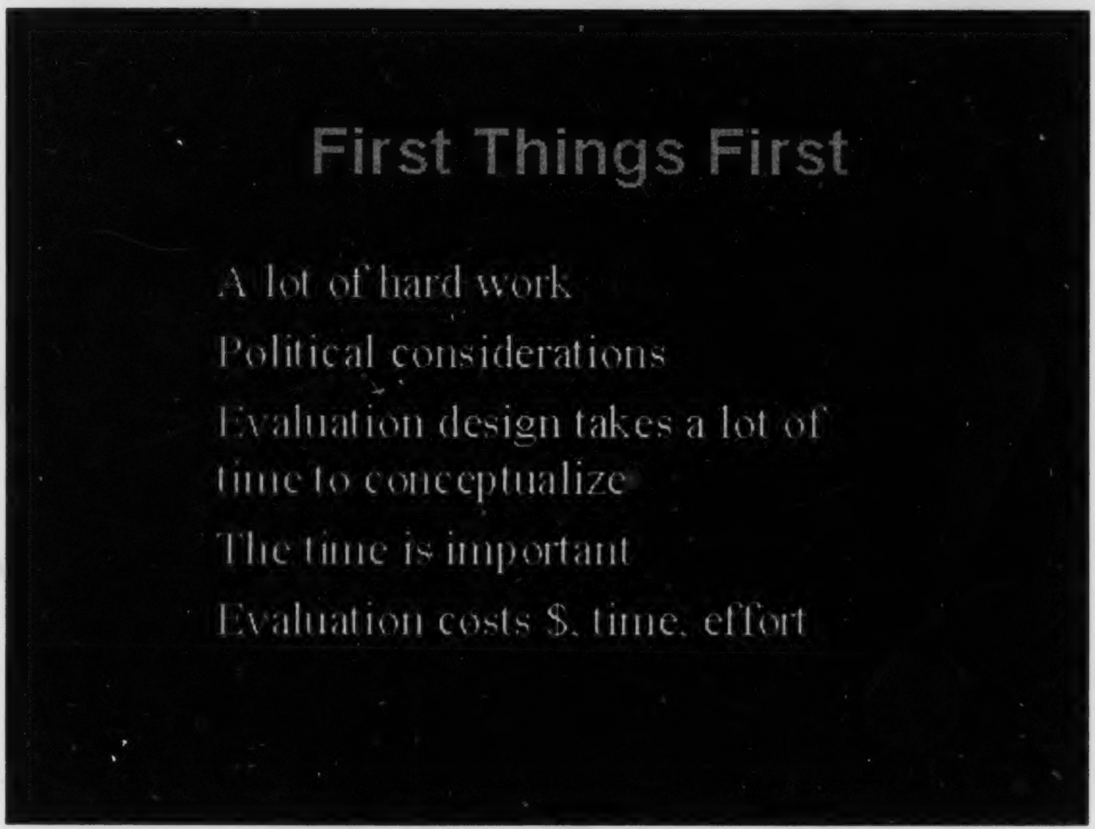

First Things First

A lot of hard work

Political considerations

Evaluation design takes a lot of time to conceptualize

The time is important

Evaluation costs $, time, effort

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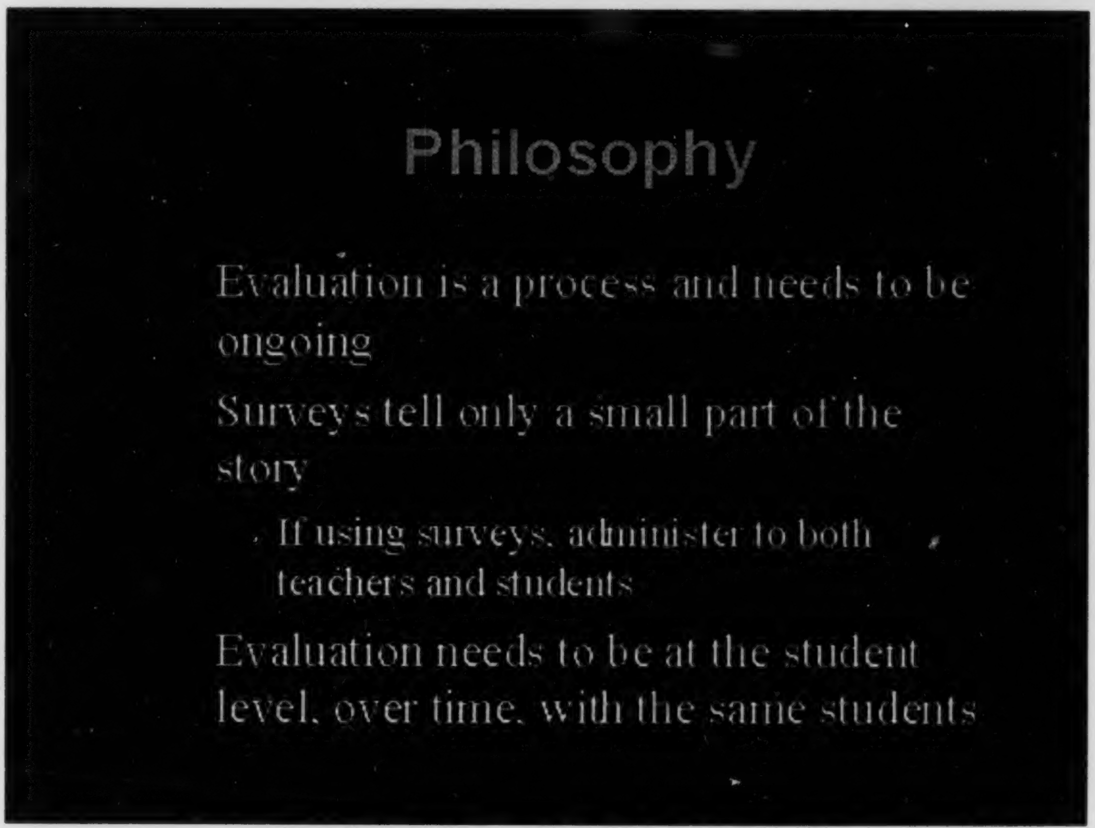

Philosophy

- Evaluation is a process and needs to be ongoing
- Surveys tell only a small part of the story
  - If using surveys, administer to both teachers and students
- Evaluation needs to be at the student level, over time, with the same students

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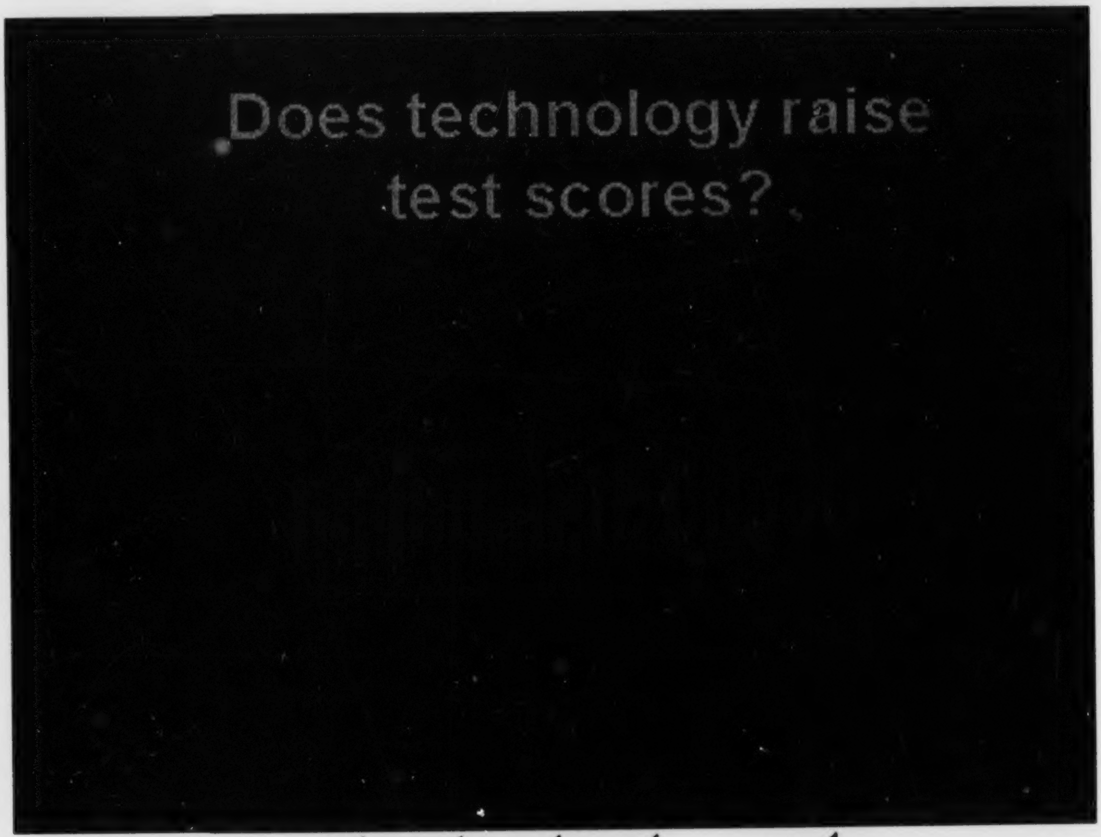

Does technology raise test scores?

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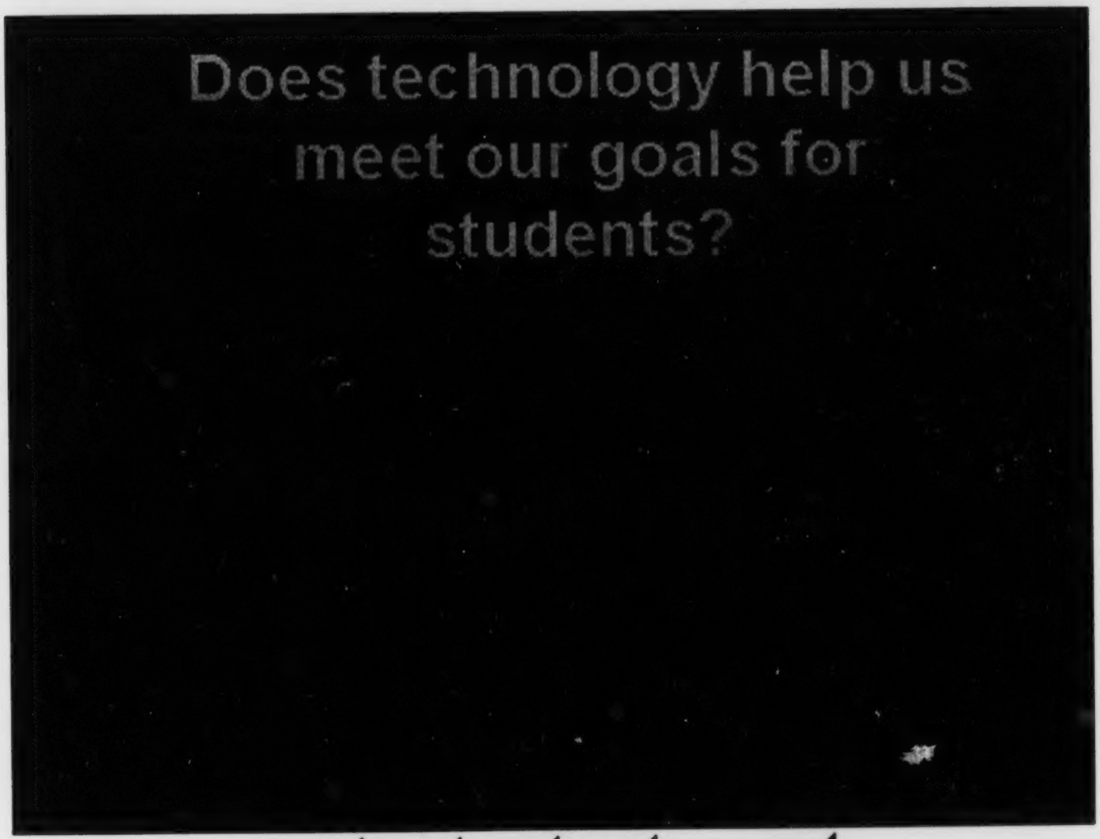

Does technology help us meet our goals for students?

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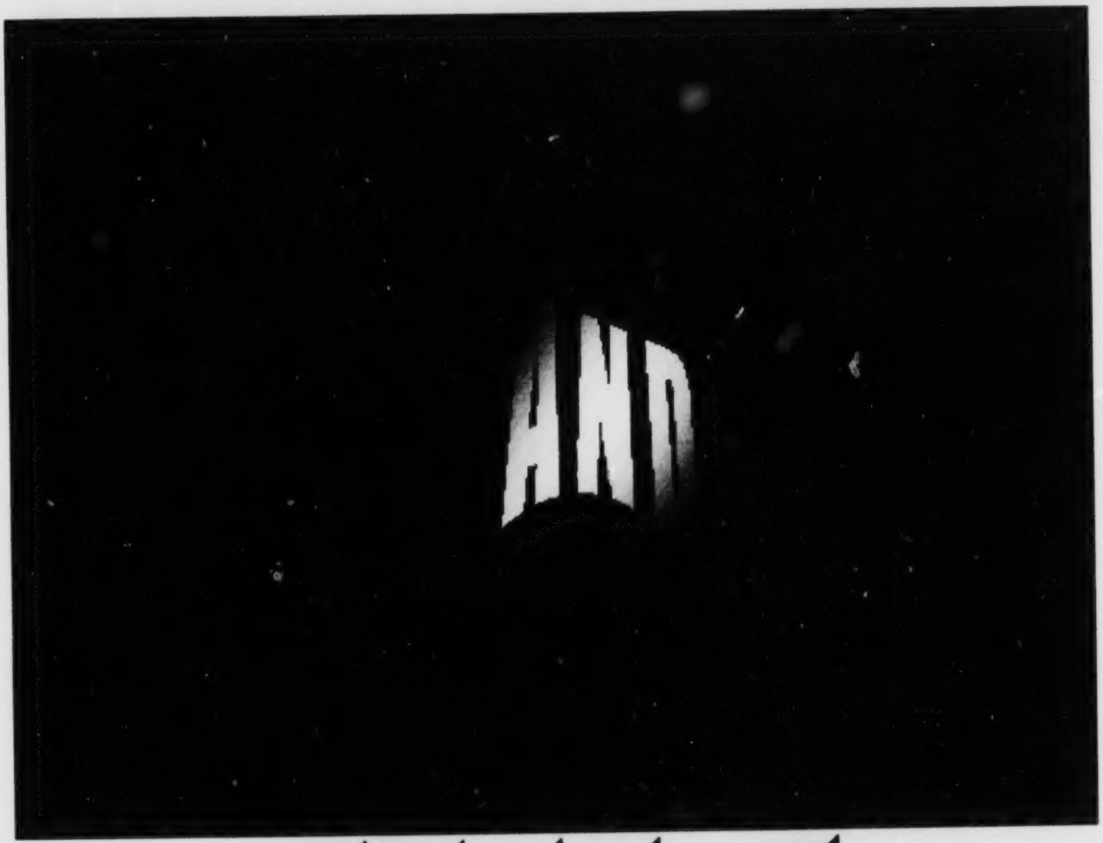

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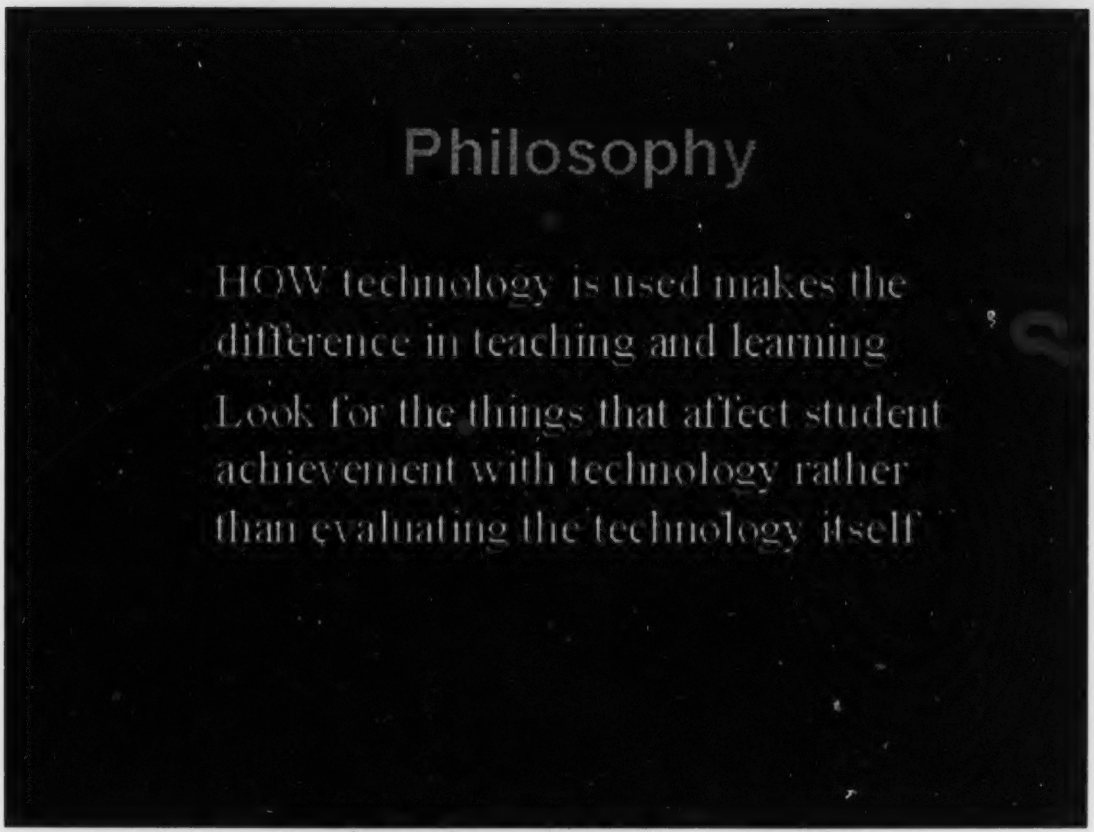

Philosophy

- HOW technology is used makes the difference in teaching and learning
- Look for the things that affect student achievement with technology rather than evaluating the technology itself

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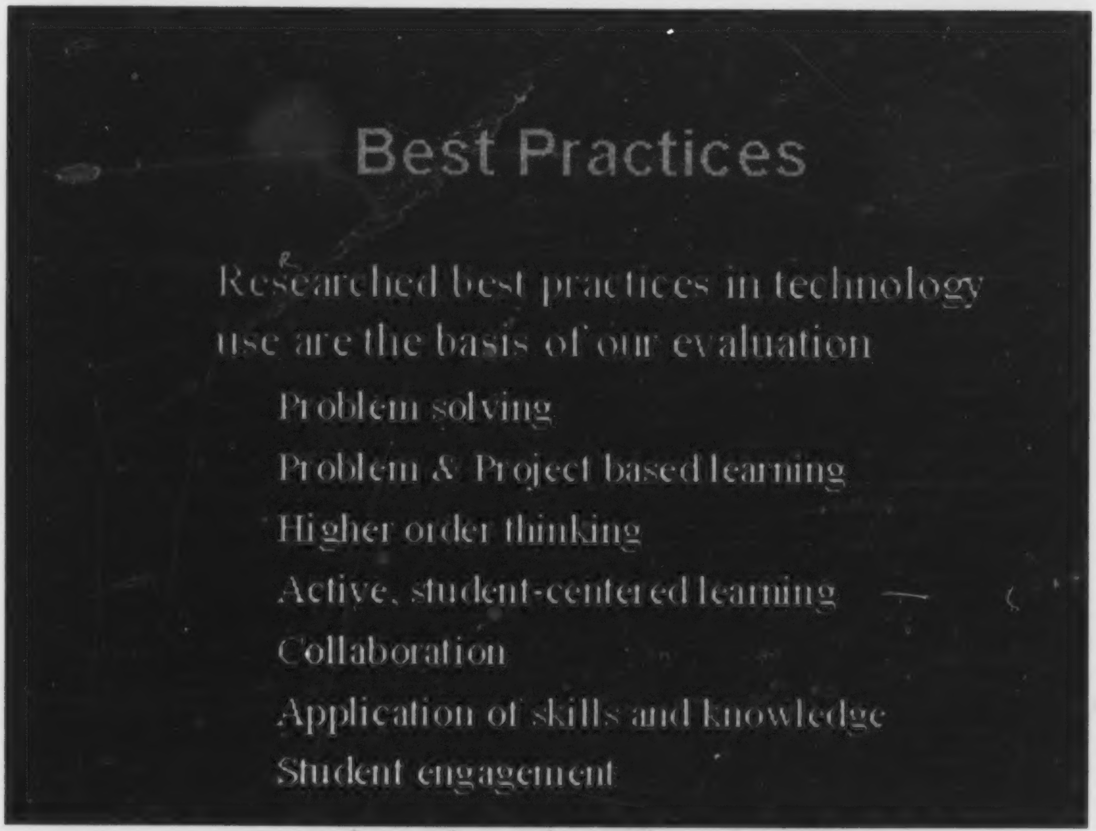

Best Practices

Researched best practices in technology use are the basis of our evaluation

- Problem solving
- Problem & Project based learning
- Higher order thinking
- Active, student-centered learning
- Collaboration
- Application of skills and knowledge
- Student engagement

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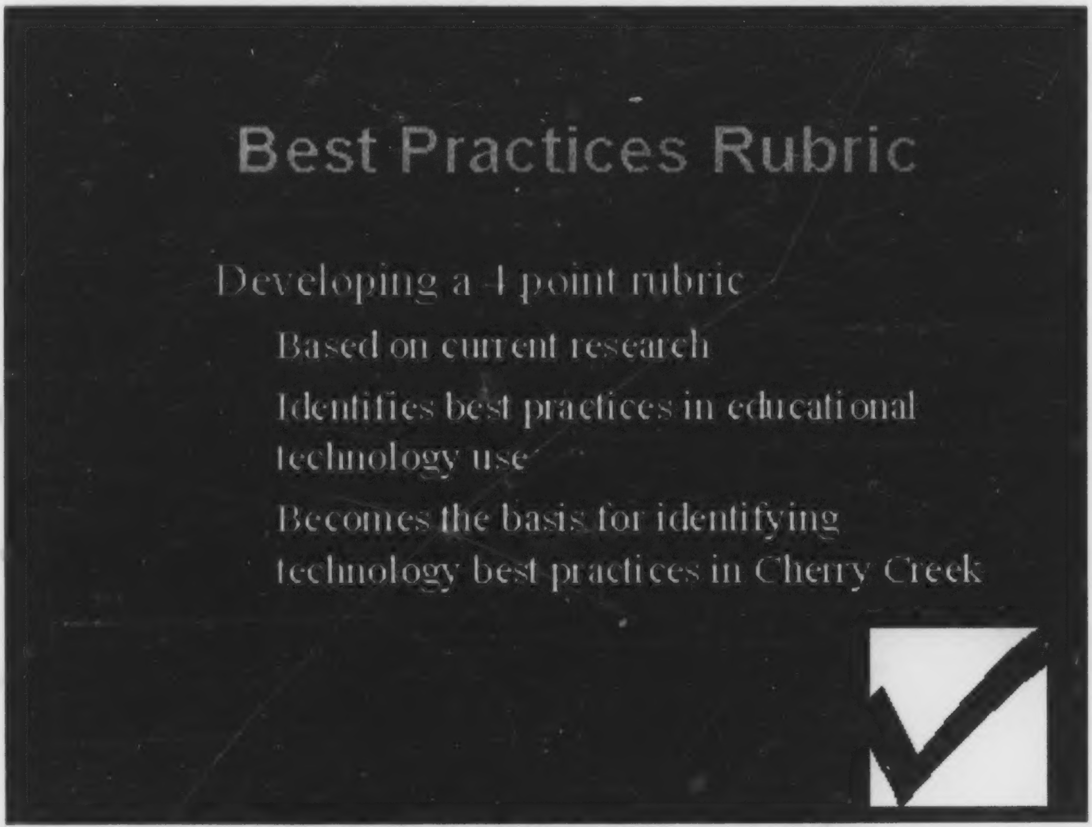

Best Practices Rubric

- Developing a 4 point rubric
  - Based on current research
  - Identifies best practices in educational technology use
  - Becomes the basis for identifying technology best practices in Cherry Creek

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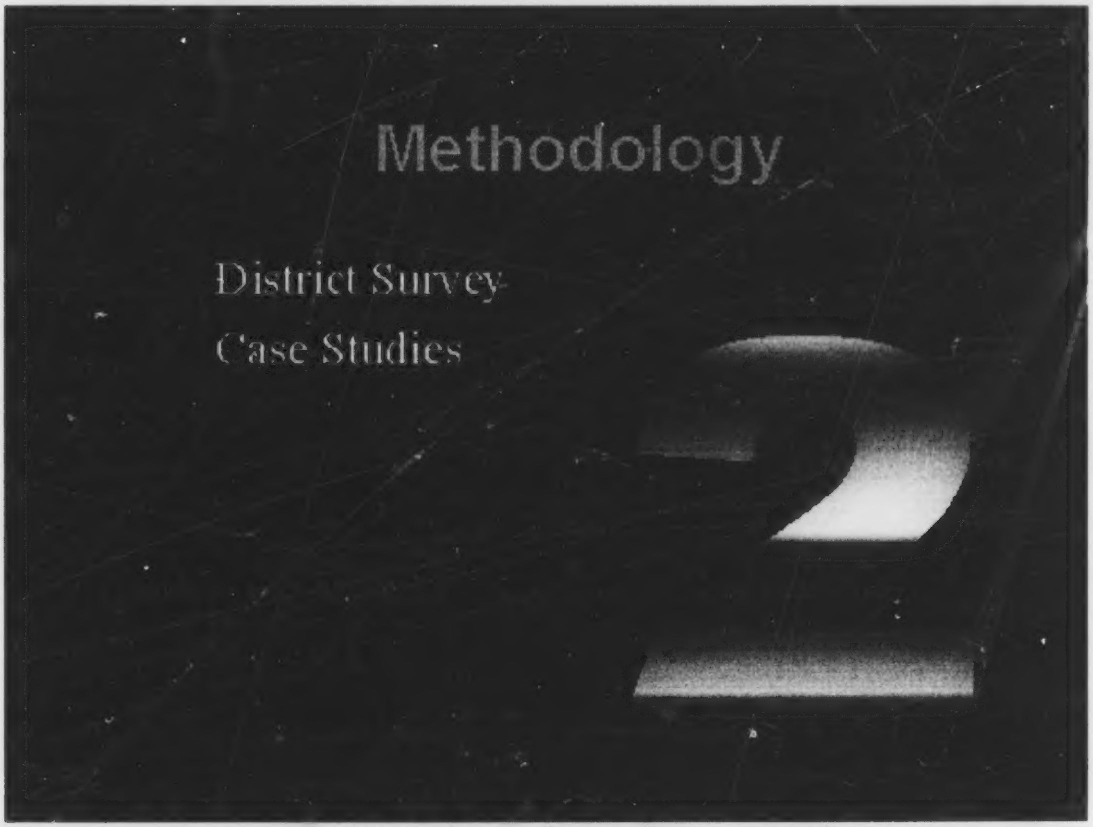

Methodology

District Survey

Case Studies

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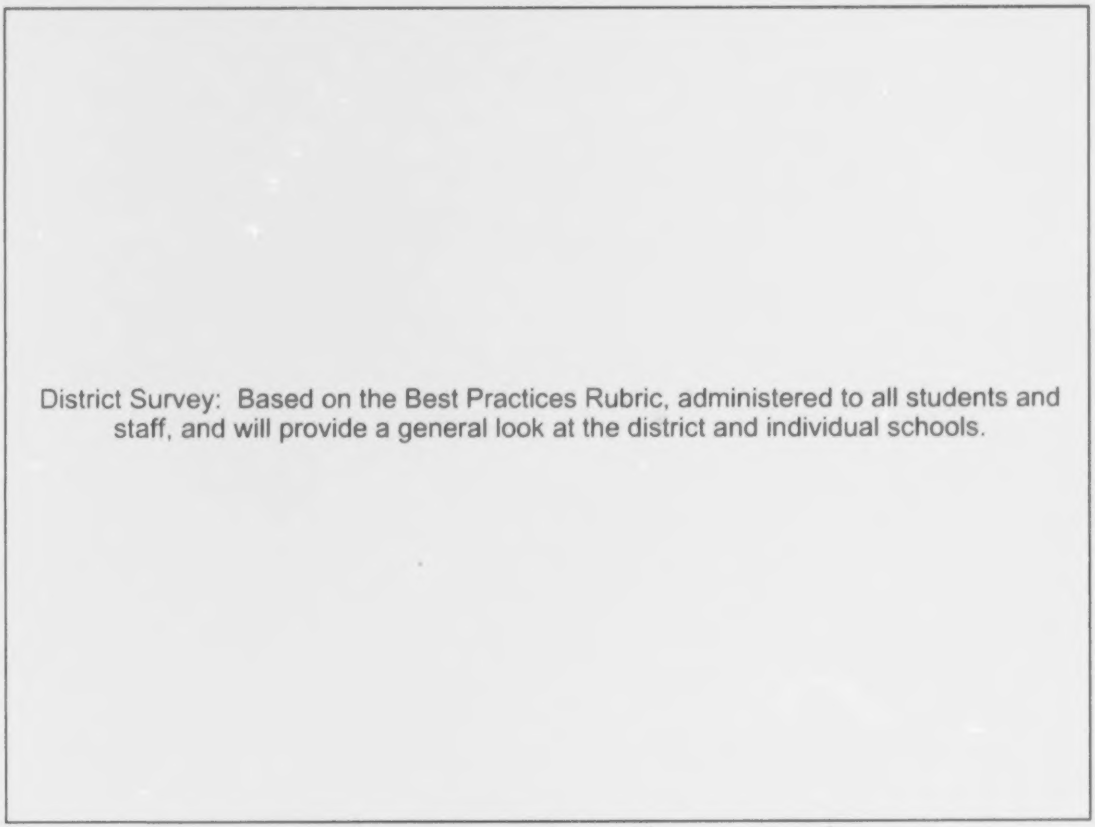

District Survey: Based on the Best Practices Rubric, administered to all students and staff, and will provide a general look at the district and individual schools.

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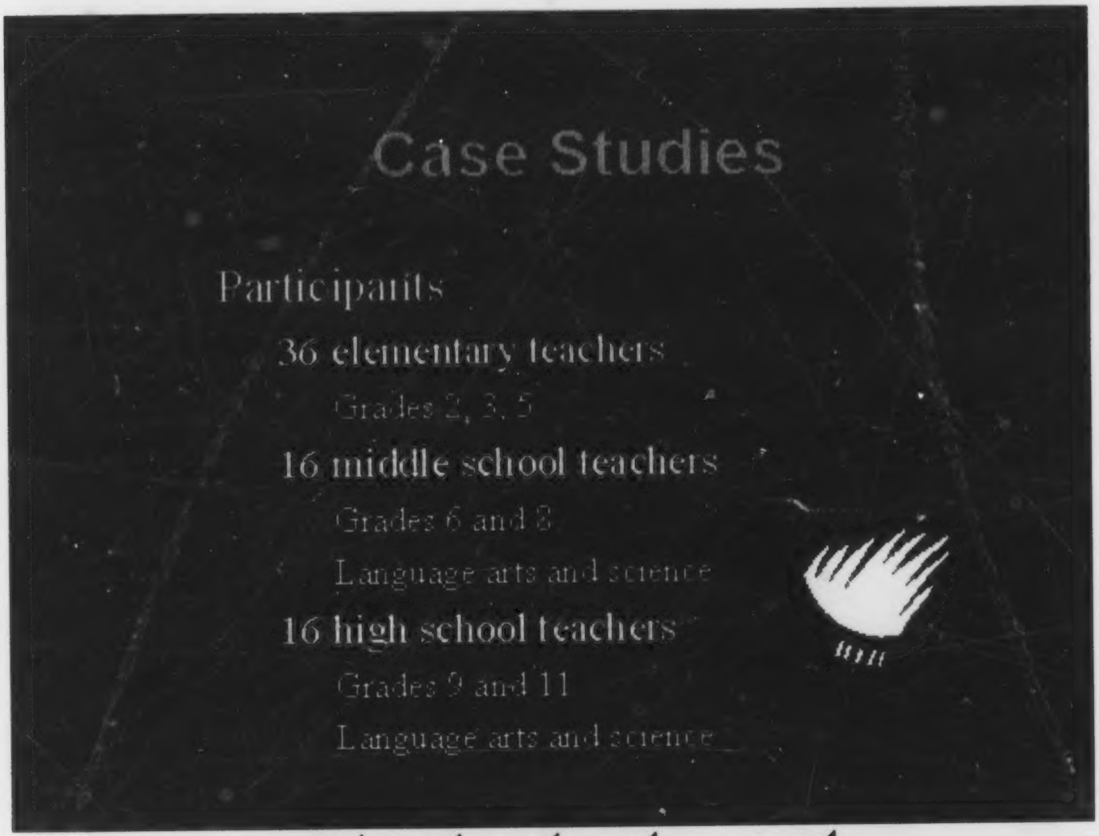

Case Studies

Participants

- 36 elementary teachers
  - Grades 2, 3, 5
- 16 middle school teachers
  - Grades 6 and 8
  - Language arts and science
- 16 high school teachers
  - Grades 9 and 11
  - Language arts and science

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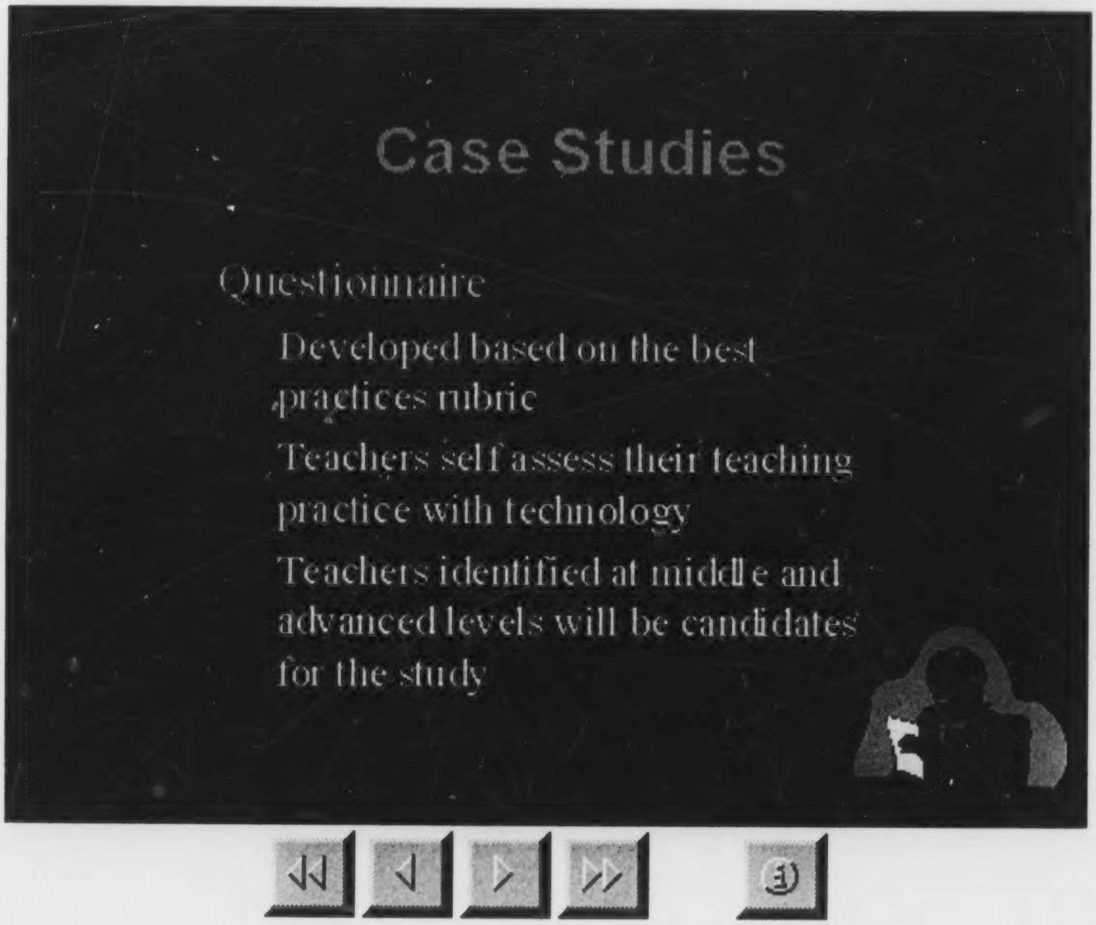

Case Studies

Questionnaire

- Developed based on the best practices rubric
- Teachers self assess their teaching practice with technology
- Teachers identified at middle and advanced levels will be candidates for the study

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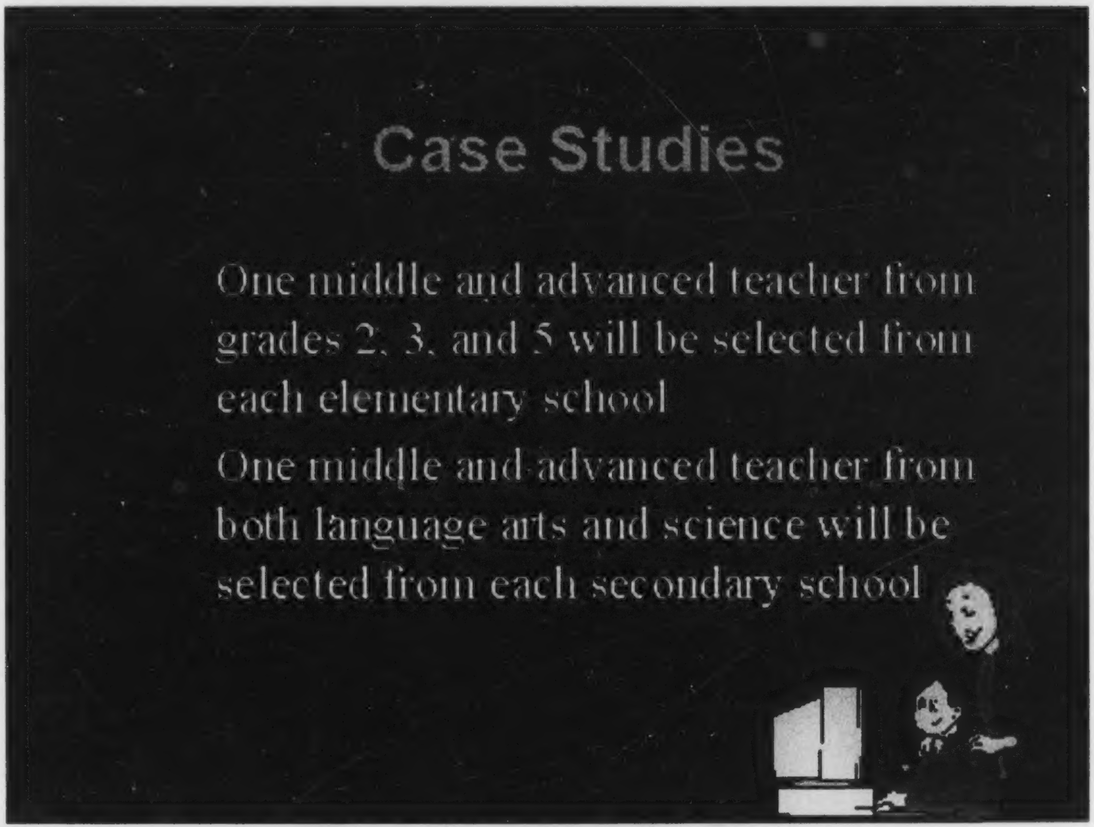

Case Studies

One middle and advanced teacher from grades 2, 3, and 5 will be selected from each elementary school

One middle and advanced teacher from both language arts and science will be selected from each secondary school

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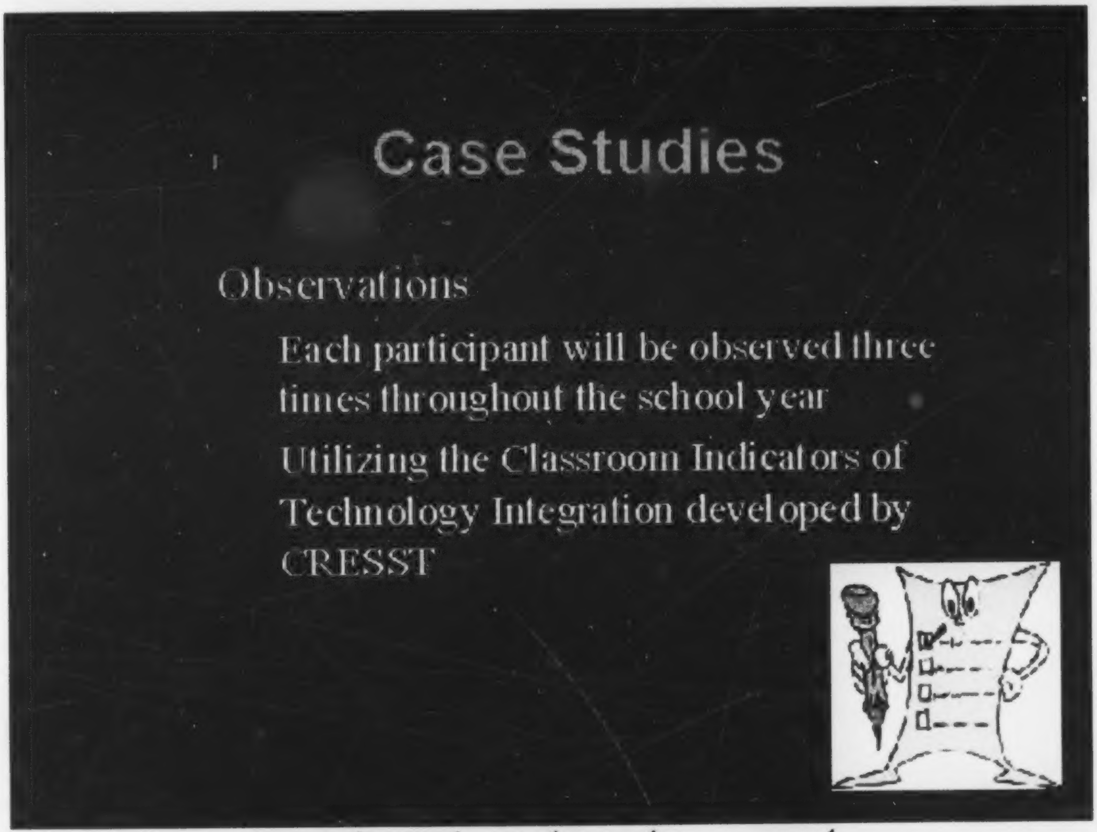

Case Studies

Observations

- Each participant will be observed three times throughout the school year
- Utilizing the Classroom Indicators of Technology Integration developed by CRESST

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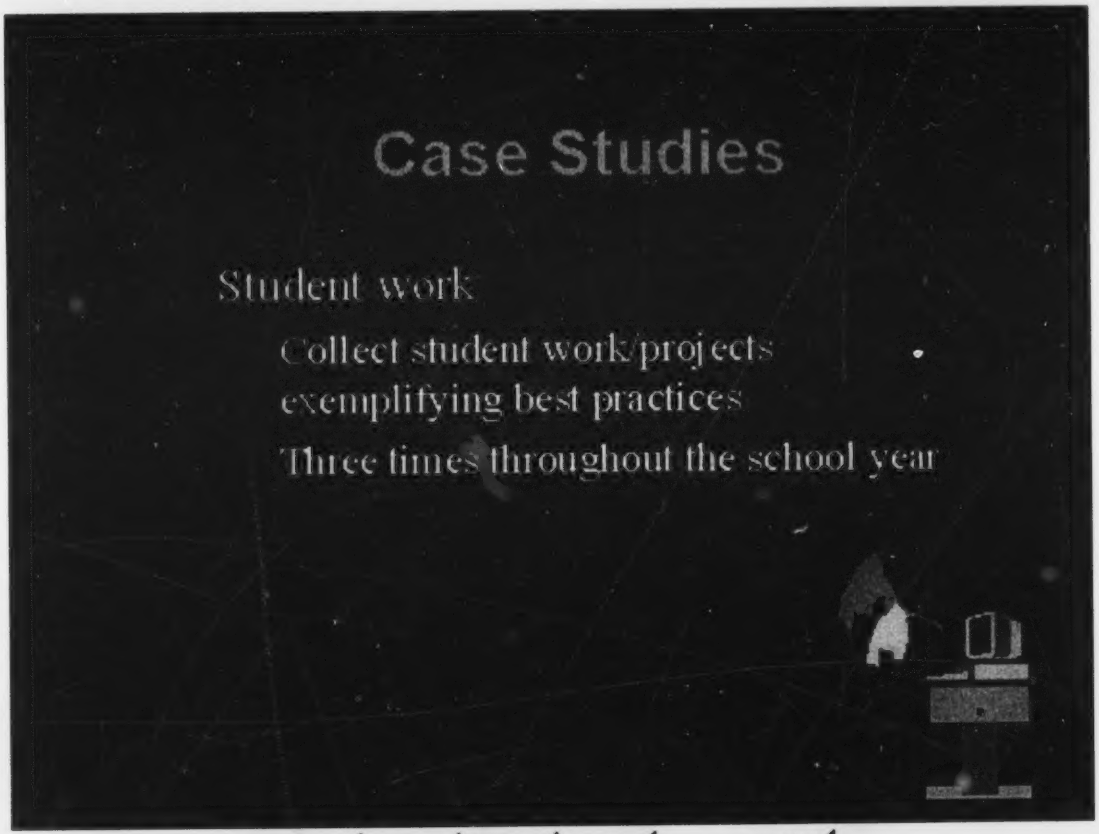

Case Studies

Student work

- Collect student work/projects exemplifying best practices
- Three times throughout the school year

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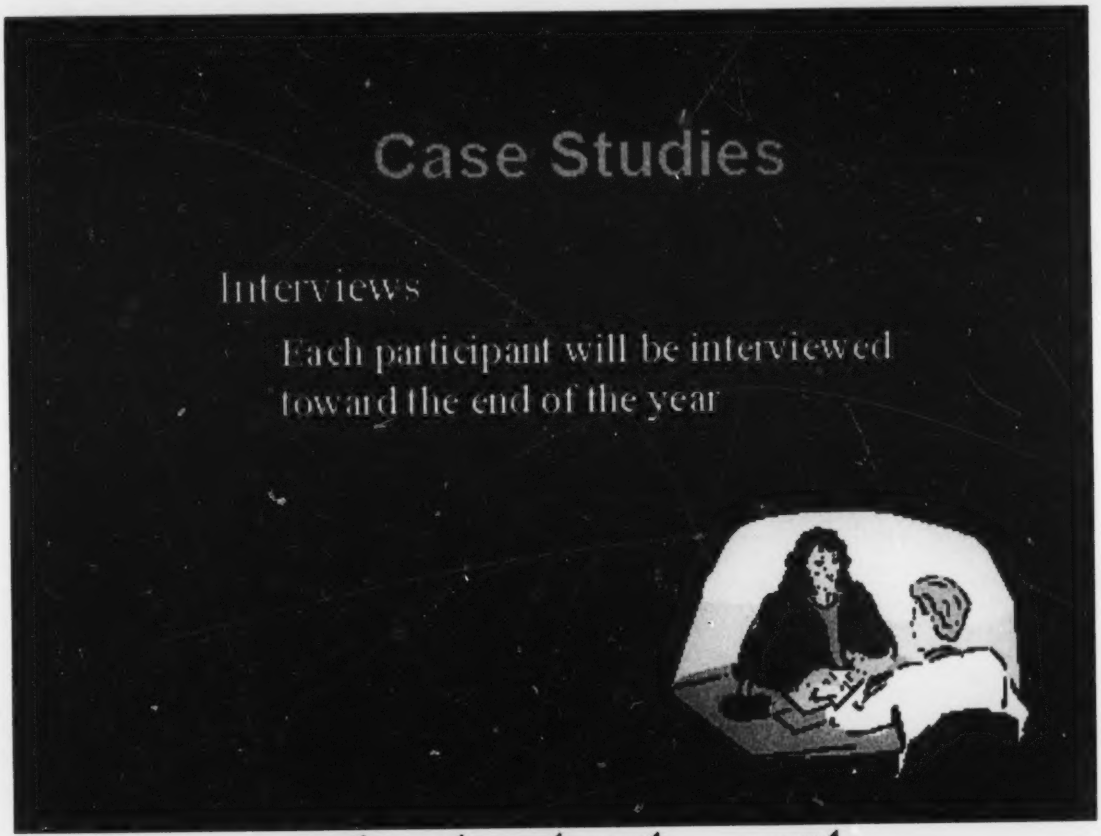

Case Studies

Interviews

- Each participant will be interviewed toward the end of the year

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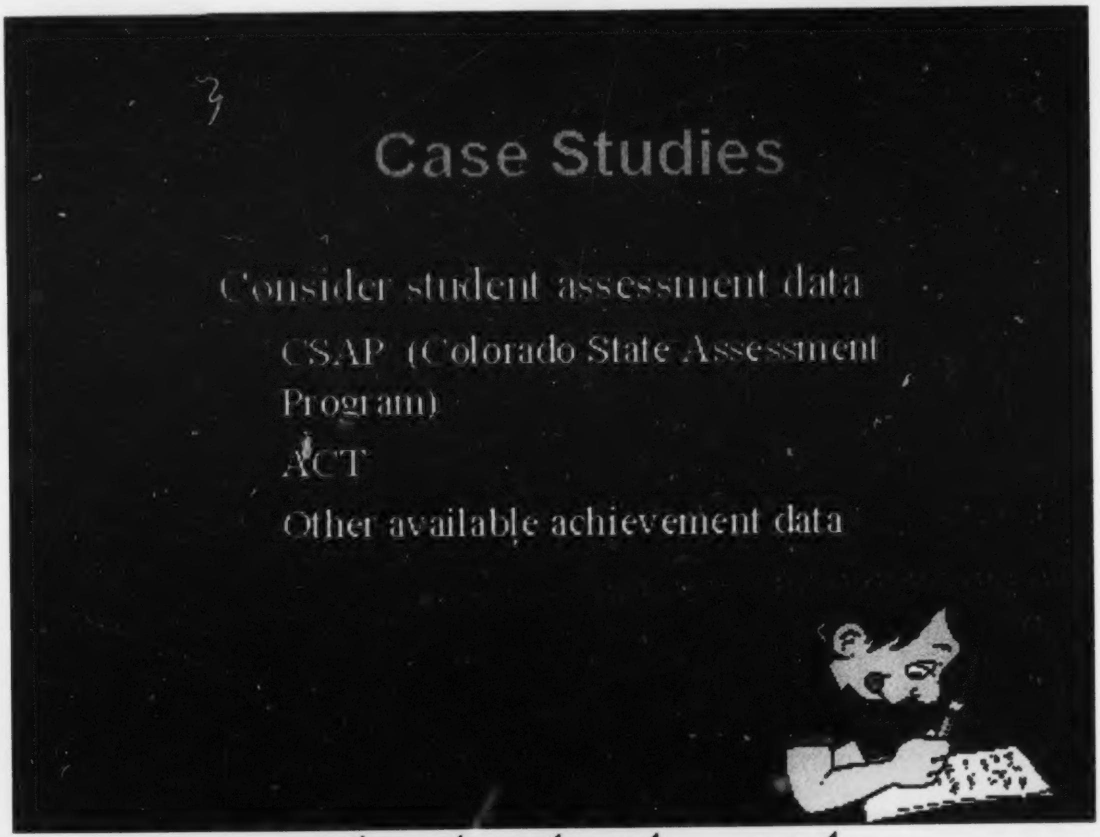

Case Studies

- Consider student assessment data
  - CSAP (Colorado State Assessment Program)
  - ACT
  - Other available achievement data

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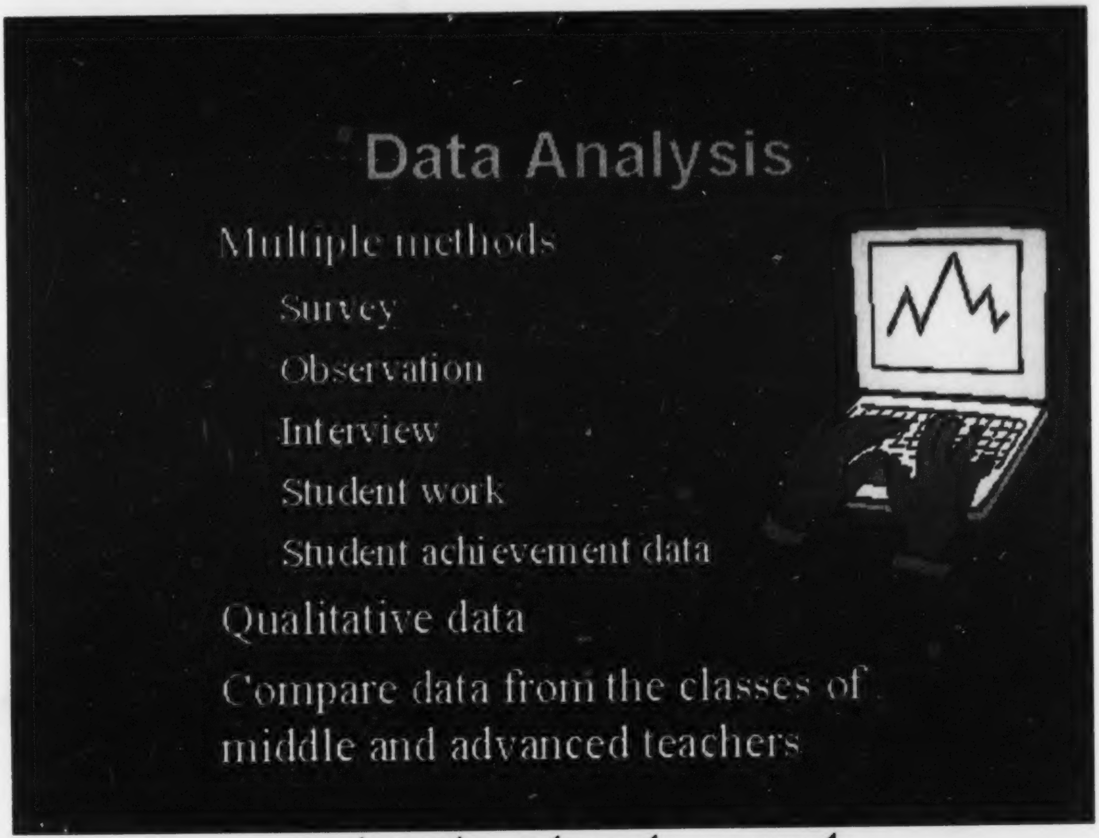

Data Analysis

- Multiple methods
  - Survey
  - Observation
  - Interview
  - Student work
  - Student achievement data
- Qualitative data
- Compare data from the classes of middle and advanced teachers

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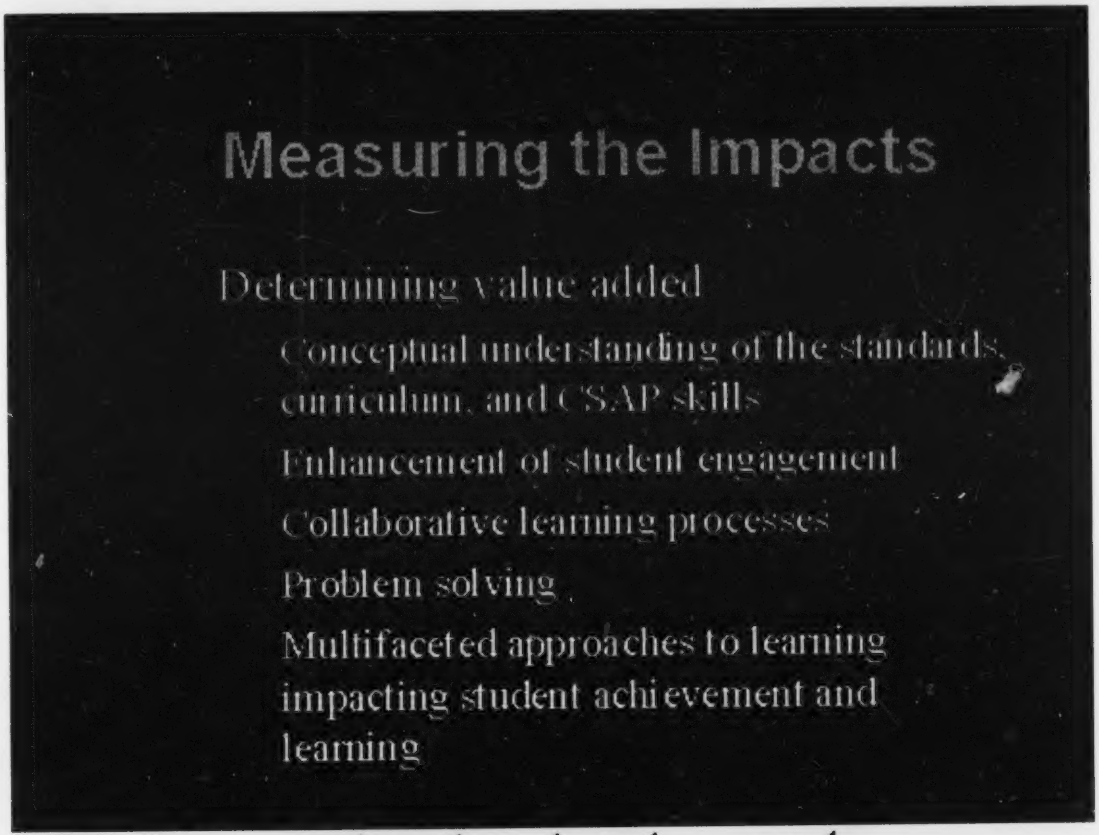

Measuring the Impacts

- Determining value added
  - Conceptual understanding of the standards, curriculum, and CSAP skills
  - Enhancement of student engagement
  - Collaborative learning processes
  - Problem solving
  - Multifaceted approaches to learning impacting student achievement and learning

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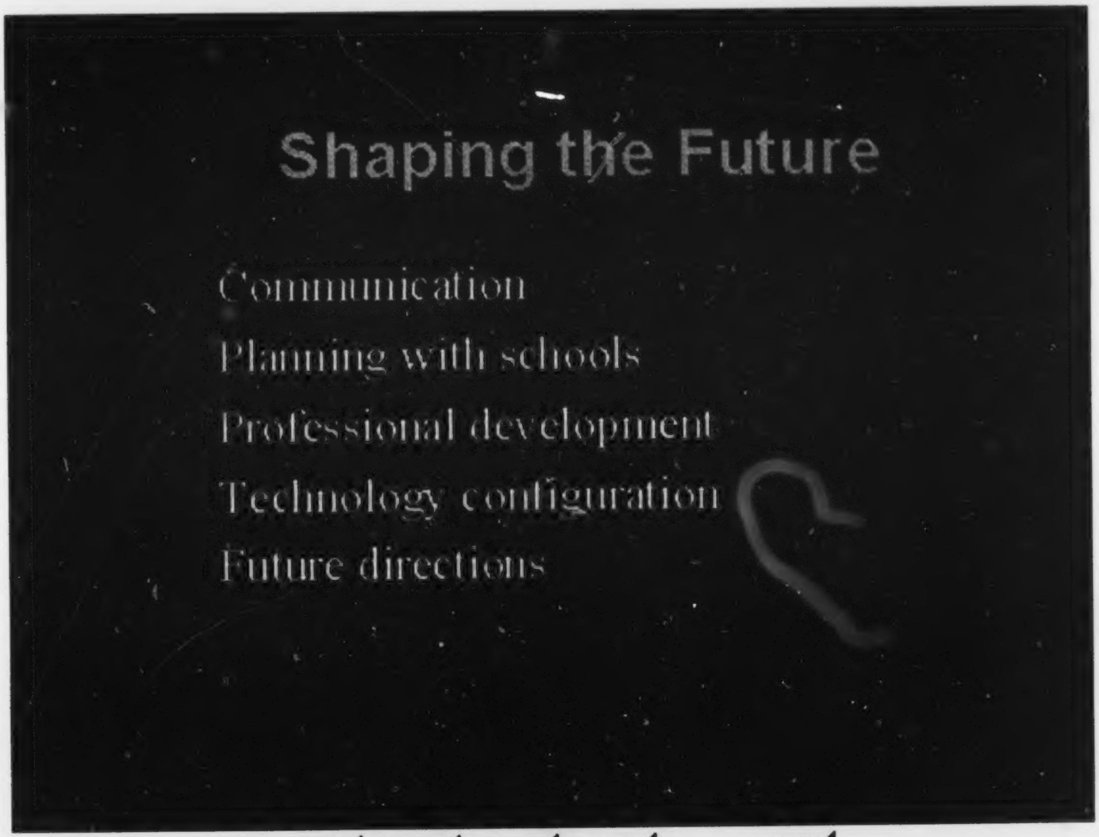

Shaping the Future

Communication

Planning with schools

Professional development

Technology configuration

Future directions

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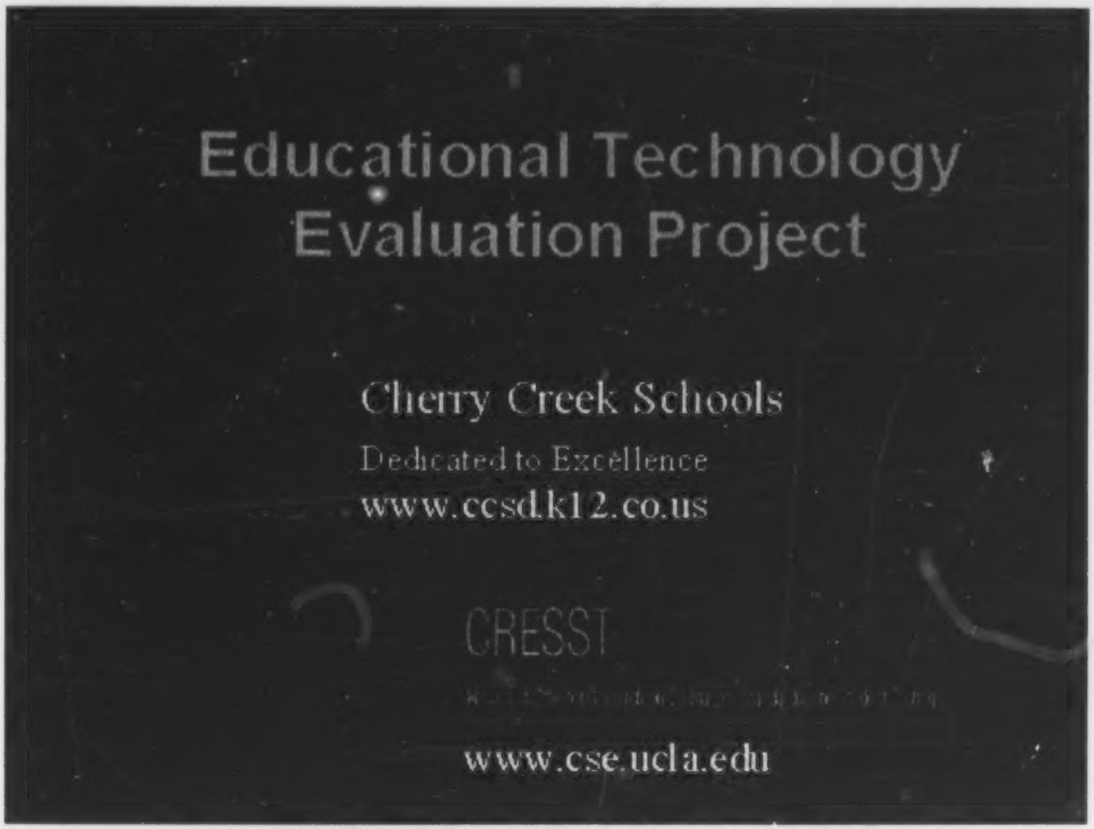

Educational Technology Evaluation Project

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www.cse.ucla.edu

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Measuring the Impact of Teaching with Technology
Comprehensive Interdisciplinary Performance Assessment

The Process of an Evaluation in Progress

Mantua Elementary – "A Basic School Powered by Technology"

> "We have all the standardized tests, and they give data that is necessary for an educator to look at and begin to develop an idea of possibly where that person might be or how they fair as to the standardized tests. But it doesn't really tell you who that child is. It doesn't really tell you what they have learned, and it doesn't give you feedback appropriately to know whether or not you are really making changes in your teaching style…."

Sarah Skerker,
Mantua Distance Learning Center

- **Purpose of the Project**
- **Drawing upon the Concerns-Based Adoption Model (CBAM)**
- **Measuring Current Approaches to Teaching with Technology**
- **For Teachers and Instructional Designers:** An Annotated Bibliography on Teaching and Learning, Performance Assessment, and Technology
- **Brief Introduction to the Teacher Inventory** (downloadable)
- **Preliminary Findings**
- **Teachers and Students Have Their Say:** Video Narrative
- **Questions We Have Raised as We Enter Fall of 2000**
- **Working with a National Panel in Year Two**
- **Digital Ethnography:** Introducing Innovations in Year Two
- **Our Own Experiences Working With Students** (A pilot project with materials for teachers to download)

This site includes an overview of Mantua Elementary School's innovative programs integrating technology with teaching and learning. Here we offer our preliminary findings from spring, 2000, and our plan for fall of 2000. Supporting this paper is an annotated bibliography on performance assessment.

We also include video clips interwoven in a brief narrative. The clips allow the teachers and students at Mantua to speak for themselves. We also provide discussion clips for you to use within your own school.

Please download a copy of the teacher inventory created for the teachers at Mantua Elementary School, or examples of rubrics and planning materials we have developed with students in a pilot project. Final findings and materials will be available on this site in winter of 2000.

Measuring the Impact of Teaching with Technology

Comprehensive Interdisciplinary Performance Assessment

Purpose of the Project

Project was developed to assist the Office of Educational Technology (U.S. Department of Education) with the follow up to the Secretary's Conference on Evaluating the Effectiveness of Educational Technology. The research and development activities with Mantua Elementary school were proposed to extend the field's understanding of how to evaluate the impact of technology initiatives in school settings.

Dr. Walter Heinecke, Laura Blasi, Dave Keefe, and other graduate students began working with Mantua Elementary School in Fairfax, Virginia from September 1, 1999 in order to develop, improve, and extend the school's current system of evaluating the effects of educational technology on student learning. We are working with Mantua throughout fall of 2000 to review, revise, and expand their current performance assessment, the CIPA, in order to improve the validity and reliability of the assessment. This process includes field-testing new or improved evaluation tools in order to collect formative and summative information.

The results will include general procedures a school system or individual school could use to design tools to evaluate and assess the impact of technology on student learning. This will include documenting what Mantua personnel have completed to date and the associated findings.

Drawing upon the Concerns-Based Adoption Model (CBAM)

Following Hall and Hord's (1984) assertion that change is a process, not an event, we have drawn upon the Concerns-Based Adoption Model (CBAM) in our design for evaluating the implementation of technology at Mantua Elementary. "When a concerns-based approach is used," explain Hall and Hord, "change facilitators work in concert with teachers to address their emerging and evolving needs" (p. 15). Guided by CBAM, we have been documenting the participant points of view -- including those of change facilitators, and those of the users and nonusers of the school innovations. We are also documenting the following elements in our evaluation design at Mantua:

- Stages of Concern
- Levels of Use

Levels of Use

❖ Innovation Configurations

Measuring Current Approaches to Teaching with Technology

Our task has been to measure the implementation and impact of current technology programs in place at Mantua. Throughout the spring of 2000, this evaluation has included their Comprehensive Interdisciplinary Performance Assessment (CIPA) and the One-to-One laptop program. After six months of observations and discussions at the school, we are working throughout fall of 2000 with teachers and administrators to further develop their current program. We are collaborating to extend the programs developed among sixth grade students to the other grades. With the teachers we are working to more closely tie the use of technology with specific content-related skills, beyond presentation skills. And we are conducting stakeholder interviews to better understand how participants envision the infusion of technology into content areas.

Preliminary Findings

Because of intense efforts at the 6th grade level, Mantua is moving forward and scaling the project up – throughout other grade levels. This year is an exciting year – with staff turnover and transitions ahead in school leadership, many of the administrators see the Comprehensive Interdisciplinary Performance Assessment (CIPA) as a door opening towards school reform.

The CIPA revisions seem to be sparking a curriculum realignment in which technology is contextualized within concern for content-related skills, applied in "real-world" simulations against the backdrop of the philosophy of Boyer's "Basic Schools". All involved with planning for fall 2000 supported the need for an emphasis on student collaboration. They also were in favor of an emphasis on group skills or "cooperative learning." Mantua will be participating in a Kagan Cooperative Learning workshop this fall.

In addition to the One-to-One laptop program, the Mantua Distance Learning Center offers many resources that are incorporated beyond CIPA (see video clip). The evaluation will need to take into account the laptop program and other resources – dovetailing instead of competing with other school efforts.

With so many media spotlights and with DOE attention, it is difficult for them to approach this without being confronted by: a) the responsibility for advancing the image of the school; b) the need to encourage the positive response of grant makers; and c) the duty positive response of grant makers; and c) the duty school members have to help a new leader transition into a stable setting, while still keeping the momentum of the projects that sought to increase student learning within and beyond standardized testing.

Observations regarding students...

- Technology-usage was strongest in terms of presentation – students developed PowerPoint slides, showed short films they had made, and displayed their work on Web pages.
- Students are synthesizing and self-organizing as they take notes on their laptops; this technology provides more resources for "visual" learners as students use drawing programs to duplicate mathematical figures.
- Students are problem-solving and trouble-shooting by using the technology, even before they integrate the content.
- When they watched other students present in prior CIPA, they recalled only prompt-specific details and were not aware of skills or strategies that could transfer.
- While they had been using Avid Cinema, and other advanced technologies, when asked about how they used technology students thought of their laptops first and foremost.
- When asked content-specific questions (such as the math formula they had used in a calculation) students seemed to improvise rather than draw from prior class experience.
- Students could "talk the talk" regarding collaboration, but at times their actions contradicted their words.

Observations regarding teachers...

- Beyond learning new ways, sometimes teachers have to unlearn "old ways" – such as the use of index cards for note-taking when a keyboard is at hand.
- Teachers assert that the ways that they grade have not changed, despite the influx of technology, but they do note a change in student products.
- The laptop is praised for disguising fine motor skill problems and learning disabilities, as

skill problems and learning disabilities, as handwriting and spelling no longer indicate students have problems.

- The mechanisms in the technology (such as spell check) may be read as student editing skills, when in fact students are not self-correcting.
- They believe that the technology allows them to move through course materials faster; they no longer need to wait for student note-taking to keep up.
- They note that the artistic side of students, beyond what is expressed through type face needs to be acknowledged; despite such "professional looking" products the age level must be remembered.

Questions We Have Raised as We Enter Fall of 2000:

- How can formative assessment during the CIPA process provide teachers with needed information?
- How can we document that information so that it can follow a student and develop during their time at Mantua?
- How can student developed assessment (such as student-created rubrics) also help students learn self-discipline, planning skills, etc.?
- How do findings from CIPA complement SOL and other test measures?
- How does technology enhance content-related skills, beyond presentation?

Working with a National Panel

We are working with Mantua teachers as they develop content-specific CIPA prompts that integrate technology in fall, 2000. Once the prompts have been developed they will be reviewed by a panel of technology experts from the content related fields at schools of education across the country. While providing input to the teachers at Mantua, we will also be able to share a range of prompts that may be adapted to suit a range of school settings. The laptops continue to play an important role as we observe how the teachers goals for student literacy impact the way they use technology in their teaching. We intend to document, if possible, how this impact is -- or is not -- evident in the final student CIPA performance.

Digital Ethnography:

Digital Ethnography: Introducing Innovations in Year Two

We are also developing new programs with them, which include the use of student-developed digital ethnography, where students in grades 5 and 6 use digital video techniques in classrooms with younger students to record learning effects related to the use of technology in these classrooms..

Our Own Experiences Working With Students
(A pilot project with materials for teachers to download)

Not only should change be experienced as a process, emphasize Hall and Hord (1984) "but the personal side of change as experienced by teachers is taken into account." In a meeting in September, 1999, teachers from Mantua discussed areas of possible improvement. They noted that towards the CIPA, their students need to learn several skills, including:

- How to manage time and plan
- Oral presentation skills
- Cooperative learning skills

Working with 7th and 8th grade students in the University of Virginia's Summer Enrichment Program, we tried several approaches to developing the skills needed in CIPA for this fall.

Our Challenge
The challenge we gave our students asked them to redesign k-8 education after they had researched Japanese education (an impossible task, but some of their insights were breathtaking). In the course of these sessions we encouraged students to distinguish between fact and opinion, while supporting their beliefs with evidence when appropriate.

Materials Developed with Students
Our efforts included the development of a rubric designed by students and a daily planning sheet, as well as a final rubric that allowed them to give confidential feedback about their group members. (We include the materials we developed with the students for you to use and adapt, examples are included). We worked with 48 students throughout the summer, dispersed over 3 ten-day-long sessions. We found that their peer evaluation often meant more to them than a grade or feedback from the instructor.

We also were able to develop a simple guide to using the Web for research based on our project focus that provided more structure for students who sought it. Throughout the three sessions we developed a journal with students that asked them to draw upon both

Internet resources (Web and e-mail) and video (a tape of a Japanese preschool), in addition to text-based resources (from books to magazines).

Encouraging Reflection

Students were also asked to refer to a "green sheet" of questions. Each day they began by responding to one of the questions, such as: "What is your role as a student?" "What do you know about education in Japan?" These questions served as prompts for the students, while recording their developing ideas.

Use of Resources

Specific materials were required -- all students had to read them and were encouraged to reference them in the final presentation. But students also had a number of text-based resources and Websites that they could choose to use. Materials were made available – but not required. In the way an adventurer might carry a supply list, student groups could check off what they had used in preparation and summarize key ideas as they went along. At the end of the two weeks, our course evaluation asked student to evaluate their own effort, and asked them to indicate which materials they had used.

Presentation Preparation

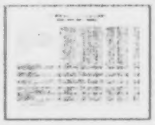
On the second week, students were required to give written feedback regarding the presentation styles of their peers in practice presentations, prior to the final presentation. On the final day, students were in charge of developing the agenda for the final presentation (an hour and a half including time for questions from the visiting panel). They presented to an external panel of experts, who then participated in a question and answer session with the students. In addition to presenting and responding to questions they were asked to take on a range of roles, including a "master of ceremonies" and a discussant who recapped the presentations.

Comparisons toward Differentiation

As the CIPA expands at Mantua, differentiation will be key to the success of the tasks encompassed by the challenge that students are given. Throughout this fall we will also be mindful of the ways that technology enhanced the educational possibilities for all students across the school. We will also note how our earliest explorations in evaluating can be adopted to meet the needs of CIPA.

Brief Introduction to the Teacher Inventory

(Click on the following icons to view the full survey)



We created this inventory to measure level of use of technology, as well as the teacher's self-perceived role as innovator, and his or her concerns regarding technology use in teaching. We wanted to record the teachers' own perceptions of their teaching style at the beginning of this year. With this goal in mind, the survey draws from the Center for Research on Information Technology and Organizations (CRITO)'s Teaching, Learning, and Computing Survey (1998).

Several of the questions in this survey draw from the stages of concern elaborated by Hall and Hord (1984, p. 60), including teacher concerns that are: related to the overall impact of innovations; related to their tasks involving the innovations; related to their personal concerns regarding the innovations; or unrelated to their school's innovations. We have asked the teachers to characterize the role of their change facilitators in terms of categories developed by Hall and Hord, aware that one person may display all of these characteristics to varying degrees. Several questions draw upon the innovation adopter categories described by Rogers in ***Diffusions of Innovations*** (1995, p. 263-266).

ROLES
EXAMPLES
BACKGROUND
RISE FEEDBACK
CONTACT INFORMATION

The Concerns-Based Adoption Model (CBAM): A Model for Change in Individuals

*Reprinted with permission from the chapter entitled " Professional Development for Science Education: A Critical and Immediate Challenge," by Susan Loucks-Horsley. **National Standards & the Science Curriculum**, edited by Rodger Bybee of the Biological Sciences Curriculum Study. Dubuque, Iowa: Kendall/Hunt Publishing Co., 1996. For more information call 1-800-KH-BOOKS (542-6657).*

Another framework that has implications for the *practices* of professional development acknowledges that learning brings change, and supporting people in change is critical for learning to "take hold." One model for change in individuals, the Concerns-Based Adoption Model, applies to anyone experiencing change, that is, policy makers, teachers, parents, students (Hall & Hord, 1987; Hord, Rutherford, Huling-Austin, & Hall, 1987; Loucks-Horsley & Stiegelbauer, 1991). The model (and other developmental models of its type) holds that people considering and experiencing change evolve in the kinds of questions they ask and in their use of whatever the change is. In general, early questions are more self-oriented: What is it? and How will it affect me? When these questions are resolved, questions emerge that are more task-oriented: How do I do it? How can I use these materials efficiently? How can I organize myself? and Why is it taking so much time? Finally, when self- and task concerns are largely resolved, the individual can focus on impact. Educators ask: Is this change working for students? and Is there something that will work even better?

The concerns model identifies and provides ways to assess seven stages of concern, which are displayed in Table 3. These stages have major implications for professional development. First, they point out the importance of attending to where people are and addressing the questions they are asking when they are asking them. Often, we get to the how-to-do-it before addressing self-concerns. We want to focus on student learning before teachers are comfortable with the materials and strategies. The kinds and content of professional- development opportunities can be informed by ongoing monitoring of the concerns of teachers. Second, this model suggests the importance of paying attention to implementation for several years, because it takes at least three years for early concerns to be resolved and later ones to emerge. We know that teachers need to have their self-concerns addressed before they are ready to attend hands-on workshops. We know that management concerns can last at least a year, especially when teachers are implementing a school year's worth of new curricula and also when new approaches to teaching require practice and each topic brings new surprises. We also know that help over time is necessary to work the kinks out and then to reinforce good teaching once use of the new practice smoothes out. Finally, with all the demands on teachers, it is often the case that once their practice becomes routine, they never have the time and space to focus on whether and in what ways students are learning. This often requires some organizational priority setting, as well as stimulating interest and concern about specific student learning outcomes. We also know that everyone has concerns-for example, administrators, parents, policy makers, professional developers-and that acknowledging these concerns and addressing them are critical to progress in a reform effort.

Professional developers who know and use the concerns model design experiences for educators that are sensitive to the questions they are asking when they are asking them. Learning experiences evolve over time, take place in different settings, rely on varying degrees of external expertise, and change with participant needs. Learning experiences for different role groups vary in who provides them, what information they share, and how they are asked to engage. For instance, addressing parents' and policy makers' question "How will it affect me?" obviously will look different. The strength of the concerns model is in its reminder to pay attention to individuals and their various needs for information, assistance, and moral support.

Traditionally, those who provided professional development to teachers were considered to be trainers. Now, their roles have broadened immensely. Like teachers in science classrooms, they have to be facilitators, assessors, resource brokers, mediators of learning, designers, and coaches, in addition to being trainers when appropriate. Practitioners of professional development, often teachers themselves, have a new and wider variety of *practices* to choose from in meeting the challenging learning needs of educators in today's science reform efforts.

Typical Expressions of Concern about an Innovation/ Table 3.

Stage of Concern	Expression of Concern
6. Refocusing	I have some ideas about something that would work even better.
5. Collaboration	How can I relate what I am doing to what others are doing?
4. Consequence	How is my use affecting learners? How can I refine it to have more impact?
3. Management	I seem to be spending all my time getting materials ready.
2. Personal	How will using it affect me?
1. Informational	I would like to know more about it.
0. Awareness	I am not concerned about it.

Levels of Use of the Innovation: Typical Behaviors

Levels of Use	Behavioral Indicators of Level
VI. Renewal	The user is seeking more effective alternatives to the established use of the innovation.
	The user is making deliberate efforts to

V. Integration	coordinate with others in using the innovation.
IVB. Refinement	The user is making changes to increase outcomes.
IVA. Routine	The user is making few or no changes and has an established pattern of use.
III. Mechanical	The user is making changes to better organize use of the innovation.
II. Preparation	The user has definite plans to begin using the innovation.
0I. Orientation	The user is taking the initiative to learn more about the innovation.
0 . Non-Use	The user has no interest, is taking no action.

From *Taking Charge of Change* by Shirley M. Hord, William L. Rutherford, Leslie Huling-Austin, and Gene E. Hall, 1987. Published by the Association for Supervision and Curriculum Development (703) 549-9110 Reprinted with permission.

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CIPA

A Comprehensive Interdisciplinary Performance Assessment

(This description was written by faculty at Mantua Elementary School)

What is a CIPA?

A CIPA is an assessment tool designed to test the effectiveness of The Basic School's interdisciplinary approach to instruction with the integration of technology in the curriculum.

Why was the CIPA created?

Because there was no assessment component to substantiate or refute the Basic School claims in contrast with the data available from the E.D. Hirsch factual/ drill approach, Mantua developed the CIPA to address the need for assessment specifically in the context of the Mantua integrated curriculum.

How was the CIPA developed?

From the beginning of our "journey", *Mantua: A Basic School Powered by Technology,* asserted that when children are exposed to interdisciplinary units powered by technology, they become literate, cooperative, problem-solving, self-motivated learners, but the problem was proving it.

Dr. Boyer had not developed an assessment model for The Basic School prior to his death, so Mantua was on its own. A committee, composed of Mantua's administrators and two teachers, met with Dr. Mary Ellen Bafumo (Director of the Basic School Network), Dr. Gloria McDonell (Director of Elementary Instruction for FCPS), Mr. James VanDien (Office of Program Evaluation, FCPS) over a two-week period to create an appropriate test. This device needed to evaluate our sixth grade students' abilities to be independent learners and problem solvers while demonstrating an integration of technology with language, mathematics and the arts. Since traditional methods of assessment (multiple choice, fill in the blank, essay, and true/false tests) could not measure this, the CIPA was born.

What are the components of a CIPA?

There are eight distinct steps in creating, administering and evaluating a CIPA.

1. Planning the CIPA content for fourth and sixth grades in the fall of the year by a team of interested individuals.

2. The CIPA would be administered in the spring of the year. The problem would be introduced on DAY ONE to the whole group as a real world scenario, designed to generate student interest and enthusiasm.

3. Students would be given an extended period of time to independently brainstorm a plan of action. This time is critical, for while we want students to solve problems in groups, we also want to evaluate individual student initial ability to problem solve. The brainstorming time could vary from an hour, to a half day. Initial plans would be kept by students and would be submitted for evaluation.

4. Cooperative groups of 4-6 would be formed in advance by the classroom teachers. These groups would include students with a cross-section of abilities and talents. As these groups are announced on DAY ONE, an adult volunteer would be assigned. In a perfect world, each group would keep the same volunteer for the duration of the assessment. Failing that, adults would be recruited by the day. These volunteers would be trained in advance by the staff to keep conditions as standard as possible throughout the groups. The remainder of DAY ONE would be spent sharing initial plans and forming a process plan of action to design an answer to the question and create a presentation of that plan.

   Each volunteer would be responsible for listening to and recording ideas, suggestions, and progress of his/her group on a provided eMate, using Learner Profile. Volunteers would be responsible for transporting students to community sites, if needed, to obtain critical information. Volunteers would also be able to answer direct questions posed by the group ONLY when the group is at a standstill due to lack of life experience. Volunteers would NOT give suggestions for process, trips, or speakers, and would not be the motivators of the group. Their role would be that of passive "fly on the wall."

5. On DAY TWO through DAY EIGHT students would spend each entire school day gathering information. Students would be expected to use resources such as the Internet, school library resources, public library resources, and information gained from experts during field trips to local sites and on the phone.

6. On DAY NINE, the presentations of solutions would take place. Each group would present before a panel of adults who would evaluate the project according to set standards. Presentations would be evaluated according to:

   - interdisciplinary inclusion of subject areas and the arts
   - group cooperation
   - problem-solving ability
   - use and integration of technology in the final product

7. All projects would be shared with the community at a SIXTH GRADE CELEBRATION OF LEARNING one evening where parents and community members would be invited to hear groups speak about their solutions to the problem.

8. Teachers would confer with each student and his/her parents prior to the end of the year. This conference would be designed to inform the parent and student of individual contributions made to the group project. It would serve as an oral summary of the elementary school experience at Mantua.

Would students be graded on the CIPA?

No. The CIPA is designed to be a culmination of group process and product learning and not a test of individual knowledge. Local businesses have told us that graduates are not able to tackle and solve a problem in a group, and we want our students to be able to have those skills early in life. Knowledge of subjects taught during the year will be evaluated in traditional methods in the classroom.

When do we have to administer the first CIPA?

The first CIPA, our test run, will be administered during the spring of 1999 to fourth (one week shortened version) and sixth grade students. An evaluation of results will take place prior to the development of the next year's test. The first officially recorded CIPA is scheduled for the spring of 2000.

What skills need to be taught, beginning in kindergarten, for sixth grade students to successfully complete a CIPA?

- Cooperative group work must be done often in every classroom in the school.
- Student should be given many opportunities for class discussions about a variety of subjects.
- Whenever possible, students need to be asked to develop a process rather than just a product.
- Higher level thinking skills should be taught and questioning during discussions should come from the high levels to stretch student brains.
- Choices must be offered to students and students should be allowed to determine their own standards and products.
- Students need to be encouraged to stretch and be different.
- Strong academic skills must be in place for a CIPA to work.
- By sixth grade, each student should be able to
    - read and analyze information from a variety of sources
    - write intelligently in many styles
    - use a computer to make spreadsheets
    - organize databases
    - create slide shows
    - use search engines
    - select valuable sites
    - word process documents

1999 CIPA

You and your group members are employees of a Think Tank, which is known for its ability to be creative, original and thorough. Because of that reputation, your group has been asked to create a new trip for a travel agency. The agency wants you to use your knowledge of our country and its contributions to design a trip for first-time visitors from a foreign land. The proposed trip title and brief description are below.

"What Are Americans All About?" or "The Culture of America"
A two to three week tour of the United States during which first-time visitors (adults of varying ages and children over eight) learn about the contributions, history, values, and goals of Americans. Included in the price of the tour is round-trip airfare from London or Paris or Rome, nightly hotel accommodations, entrance prices into all sites, ground or air transportation between cities, and breakfast and lunch each day.

The tour company needs a trip itinerary, which clearly details a day-to-day run down of routes, sites to be visited, hotels and meals. They require a cost breakdown, and a final price, per person for the trip (based on two people from the same family staying in the same room each night). For the tour to be appealing to the public, they suggest that the total price per person not exceed $4,000. Each tour group will contain no more than 48 people.

You must:

a. determine who Americans are, what sites would help visitors to learn about the history of the country, what contributions have been made by Americans that can be shown, and decide what the general values and goals of Americans are
b. determine a route and method of travel while in the U.S.
c. designate stops for sight seeing, including what will be learned at each site, places to eat, and overnight stays-the more details the better
d. have the trip last 14 days (leave home on day 1, return on day 14)
e. determine a per person rate for the trip
f. calculate a 10% discount for the "land portion" of tours (everything except airfare) for children under 17
g. keep a complete log of your resources (calls, interviews, books, magazines, Internet sources)

Your presentation to the agency is **due on** _______________ . It should include attractive displays of information and a clear justification for your choices. Each presentation has been limited to 30 minutes. Remember that your presentation will be a sales job. The agency will be looking for attention to requirements and details, and an ability to be creative and original and have a professional attitude. The winning firm will receive hefty cash bonuses in their year-end checks.

Final presentation ideas:
Charts, graphs, posters, brochures, spreadsheets, original videos, graphics, pictures, photographs, and multimedia presentations such as HyperStudio, mPower, Claris slide show, Avid Cinema are among some of your options.

Hint: A combination of many types of media makes a presentation much more interesting. Remember that people in an audience often like having a handout to refer to while watching a larger presentation.

1999 CIPA

You and your group members are employees of a Think Tank, which is known for its ability to be creative, original and thorough. Because of that reputation, your group has been asked to create a new trip for a travel agency. The agency wants you to use your knowledge of the development of Western Civilization to design a trip for first-time visitors from the United States. The proposed trip title and brief description are below.

"America's European Roots"

A two or three week tour of Europe during which American visitors (adults of varying ages and children over eight) will learn about Western Civilization and its impact on the development of American culture. Included in the price of the tour is round-trip airfare from either Dulles, Reagan International or BWI Airport to your first city of interest, nightly hotel accommodations, entrance prices into all sites, ground or air transportation between cities, and breakfast and dinner each day.

The tour company needs a trip itinerary, which clearly details a day-to-day run down of routes, sites to be visited, hotels and meals. They require a cost breakdown, and a final price, per person for the trip (based on two people from the same family staying in the same room each night). For the tour to be appealing to the public, they suggest that the total price per person not exceed $4,000. Each tour group will contain no more than 48 people.

You must:

a. decide which events in the history of Western Civilization shaped American culture and which sites would help visitors to learn about this development
b. determine a route and method of travel while abroad
c. designate stops for sight seeing, including what will be learned at each site, and overnight stays-the more details the better
d. have the trip last 14 days (leave home on day 1, return on day 14)
e. determine a per person rate for the trip
f. calculate a 107o discount for the "land portion" of tours (everything except airfare) for children under 17
g. keep a complete log of your resources (calls, interviews, books, magazines, Internet sources)

Your presentation to the agency is due on _______________ . It should include attractive displays of information and a clear justification for your choices. Each presentation has been limited to 30 minutes. Remember that your presentation will be a sales job. The agency will be looking for attention to requirements and details, and an ability to be creative and original and have a professional attitude. The winning firm will receive hefty cash bonuses in their year-end checks.

Final presentation ideas may include:

Charts, graphs, posters, brochures, spreadsheets, original videos, graphics, pictures, photographs, and multimedia presentations such as HyperStudio, mPower, Claris slide show, Avid Cinema are among some of your options.

Hint: A combination of many types of media makes a presentation much more interesting. Remember that people in an audience often like having a handout to refer to while watching a larger presentation.

Rubric for Evaluation CIPA Presentations

	Beginning	Developing	Accomplished	Exemplary	Score
Overall Aesthetics					
Overall visual appeal of final project	0 points No visual elements.	1 point Few visual elements. OR Text difficult to read.	2 points Two or three different media used.	3 points Appealing visual elements are included appropriately. Various media used including pictures, photographs and downloaded images, slide shows, films, hard copies.	
Introduction					
Motivational effective of Introduction	0 points No introduction.	1 point Introduction was purely factual with no appeal to audience.	2 points Introduction related somewhat to the audience's interests and/or described the problem.	3 points The Introduction drew the audience in by relating the problem in an interesting/creative/ original way.	
Task					
Cognitive level of the task	0 points Presentation showed no comprehension of material.	3 points Presentation showed simple comprehension of material.	6 points Task showed analysis of information and/or putting together information from several sources.	9 points Task showed synthesis of multiple sources of information, and/or taking a position, and/or going beyond the data given and making a creative and original product.	
Process					
Richness of process of presentation	0 points Disorganized, not planned	1 point Traditional speech presentation.	3 points All group members presented some variety in presentation.	6 points Lots of variety in presentation. Many different components presented (computer, video, hard copy).	
Resources					
Quantity of resources	0 points No resources used.	1 point Few online and library resources used. (1-2)	2 points Moderate number of online and library resources used. (3-4)	3 points Many resources provided including online, library and personal interviews. (5+)	
Quality of resources	1 point Could be found in a school library.	2 points Information not ordinarily found in a school was used, but was all from books.	3 points Information used from travel books, trip brochures, and interviews, but was all from books.	4 points Excellent use of the Web's timeliness and including books, brochures, interviews and visits.	
TOTAL SCORE					

Oral Presentation Rubric

Your name: ____

Group Members: ____

Oral Presentation Rubric	**Possible Points**	**Self-Assessment**
Provided depth in coverage of topic.	10	
Presentation was well planned and coherent.	10	
Explanation and reasons were given for decisions.	10	
Communication aids were clear and useful.	10	
Handout was useful for others interested in topic.	10	
Bibliographic information for others was complete.	10	
Total Possible Points	60	

Rate each category according to the following scale:

9 - 10 = excellent
7 - 8 = very good
5 - 6 = good
3 - 4 = satisfactory
1 - 2 = poor
0 = unsatisfactory

Oral Presentation Rubric

Your name: ____

Group Members: ____

Oral Presentation Rubric	**Possible Points**	**Committee Assessment**
Provided depth in coverage of topic.	10	
Presentation was well planned and coherent.	10	
Explanation and reasons were given for decisions.	10	
Communication aids were clear and useful.	10	
Handout was useful for others interested in topic.	10	
Bibliographic information for others was complete.	10	
Total Possible Points	60	

Rate each category according to the following scale:

9 - 10 = excellent
7 - 8 = very good
5 - 6 = good
3 - 4 = satisfactory
1 - 2 = poor
0 = unsatisfactory

Daily Collaboration Rubric

	Beginning	Developing	Accomplished	Exemplary
Contribute				
Research & Gather Information	Did not collect any information that related to the topic.	Collected very little information—some related to the topic	Collected some basic information—most related to the topic	Collected a great deal of information—all related to the topic.
Share Information	Did not relay any information to teammates	Relayed very little information—some related to the topic.	Relayed some basic information—most related to the topic.	Relayed a great deal of information—all related to the topic.
Take Responsibility				
Fulfill Team Role's Duties	Did not perform any duties of assigned team role.	Performed very little duties.	Performed nearly all duties.	Performed all duties of assigned team role.
Share Equally	Always relied on others to do the work.	Rarely did the assigned work—often needed reminding.	Usually did the assigned work—rarely needed reminding.	Always did the assigned work without having to be reminded.
Value Others' Viewpoints				
Listen to Other Teammates	Always talked—never allowed anyone else to speak.	Usually did most of the talking—rarely allowed others to speak.	Listened, but sometimes talked too much.	Listened and spoke a fair amount.
Cooperate With Teammates	Usually argued with teammates.	Sometimes argued.	Rarely argued.	Never argued with teammates.
Make Fair Decisions	Usually wanted to have things their way.	Often sided with friends instead of considering all views	Usually considered all views.	Always helped team to reach a fair decision.

Basic School Evaluation Component

Group # _______

Members ____

Integrated use of:

Mathematics

	Laptop	multimedia computer	calculator	paper
spreadsheets				
averages				
cost totals				
currency conversion				
accuracy				

Language

______Coherent written work
______Proofreading
______Editing
______Effective oral communication

Art

______Visits to museum
______Balance/color/aesthetics of presentation considered
______Important works of art included in presentation
______As reference source

Music

______Concerts (included in tour)
______As reference source
______Included in presentation
______Soundtrack

Drama

______Plays (included in tour)
______Theater in London
______Dramatic elements used in presentation

Dance/Movement

______Dance
______Movement included in presentation

Technology used in preparation

Computer (indicate Laptop or Multimedia
- _____notes
- _____spreadsheets
- _____currency conversions
- _____time zones

Skills Observed:
- ______download information from web
- ______import pictures
- ______design web page
- ______take and use video
- ______take/use digital pictures

Software used:
- ______Internet Explore/Netscape
- ______Claris word processing / s preadsheet/database
- ______mPower
- ______HyperStudio
- _____Kid Pix Slide Show
- ______Avid Pix Slide Show
- ______Avid Cinema
- ______Arc View
- ______Web Page Makers
- ______DVDs
- ______CDs
- ______Other

Hardware used:
- ______Multimedia computer
- ______Videoconferencing
- ______CCTV
- ______Smartboard
- ______Scanner Digital Camera
- ______Video Camera
- ______Document Cameras
- ______Copy Machine

Primary Source information

- ______Phone contact
- ______Personal interviews
- ______field trip

- ______Internet
- ______newspaper
- ______other (specify)

Climate for Learning

______Group member shows excitement for learning

Group dynamics
- _____designates roles
- _____plans jobs/tasks
  - _____communicates expectations of members

Flexible grouping
  - _____matches individual strengths with task

Other observations:

Commitment to Character

Group shows:

Respect
___for members for parents
___Adults on field trips
___during phone calls

Compassion
___for members who are ill/suffering with allergies
___for members who run into problems
___for others who run into problems

Caring
___for members who experience problems
___for others who experience problems

Giving
___for members who need help
___for others who need help

Honesty
___in log-keeping
___during daily evaluations and discussions

Responsibility
___for task completion
___for organization of material
___for being in correct location (not wandering

Perseverance
___when task get complex
___when information is difficult to locate

The Mantua Distance Learning Center at Mantua Elementary: A Basic School Powered by Technology

(This description was written by faculty at Mantua Elementary School)

At Mantua Elementary-Mantua Center, we are committed to extending educational experiences beyond the classroom and to creating a distributed learning environment that facilitates the active participation of all students and teachers in the learning process. Our newest classroom, the Mantua Distance Learning Center, opened in December 1998. It features state-of-the-art videoconferencing, video production, and computer equipment to provide flexible teaching and learning environments that accommodate different learning styles and individual learning paces. Believing that it is a powerful instrument in the efforts to break down barriers to education and improve the quality and availability of education to everyone, the students and teachers of Mantua are prepared to pioneer the use of two-way, interactive distance learning within elementary education.

The Mantua Distance Learning Center is supported by two grants from Bell Atlantic-Virginia totaling $120,000. The Center integrates four educational technologies:

- real-time videoconferencing;
- closed-circuit TV;
- video production; and,
- interactive computer instruction.

We have been able to successfully integrate these educational technologies with art, language arts, social and physical sciences, history, and mathematics by focusing on the connections across academic disciplines. Within this paradigm, technology is not an end to itself, but rather the transparent set of tools that facilitates discovery and visualization of ideas.

Recognition of Need:
Mantua Center: Our Profoundly Deaf Population

Interactive distance learning addresses the learning needs of students at all levels of academic and language ability. It is especially useful, however, to the Deaf community. Interactive distance learning through videoconferencing provides access for individuals using American Sign Language to communicate and share ideas. The highly visual nature of multimedia software—pictures, sign video inserts, graphics, animation, and captioning is particularly suited for students with hearing losses (Pollard, 1993; King, Noretsky, Larkins & Naumann, 1993).

This year Mantua Center is tasked with educating seventy severe to profoundly deaf children. These students range in ages from several months to thirteen years and represent twenty ethnic minorities and families who speak a primary language other than English.

Use of two-way interactive distance learning offers deaf children new options beyond pencil and paper for shared learning, exposing them to a broader base of educational and cultural opportunities. Our goal, as we provide visual access to learning for deaf students at Mantua Center, is to serve as a national demonstration site for developing ways to use technology for building literacy skills. Providing visual input for concepts increases understanding for all learners. This model would be adaptable for use in other special education and general education programs across Fairfax County, the state of Virginia, and the nation.

The Value Added by Videoconferencing:

The videoconferencing function is implemented through a Tandberg Educator 5000 system and ISDN lines dedicated to our Distance Learning Center. This system differs from more conventional instructional delivery methods (e.g., web-based videoconferencing) by providing full-motion compressed video. This is critical to educational situations where movements must be conveyed with precision.

Videoconferencing has proven to be an effective tool for student collaboration and it is an essential tool for achieving one of our primary educational goals: preparing students for the mobile and remote workplaces of the next century. Students engage in collaborative learning experiences with other students in Fairfax County, the nation, and around the world. We are currently working with Logical Transitions Incorporated, Tybee Island, Georgia to develop a series of videoconference tours for various grade levels that target specific Fairfax County Program of Studies and Virginia Standards of Learning. The tours span a range of topics. Among these are: Weather along the Southeastern United States, Civil War history of Savannah and Tybee Island, the Math and Science behind making Candy, and a Visit to the Dentist.

Last year, a sixth grade class of deaf students began conducting videoconferences with students from the Pennsylvania School for the Deaf and the Colorado School for the Deaf. This year we are building upon that success and connecting with additional schools in California, Indiana, and Wisconsin. The students are not only learning about other parts of the country and expanding their language skills, they are meeting deaf peers and broadening their scope of understanding about the world. Several students expressed astonishment that deaf programs exist in other parts of the United States.

Research has demonstrated that the process of teaching and learning in the classroom can become significantly richer for **all** when there is access to new information technologies and the assurance of effective, high quality technology training for teachers and administrators. Dr. Linda Roberts, Director of Educational Technology at the United States Department of Education speaks often of the major and rapid paradigm shift that is occurring in education. A shift that requires students in the Information Age to be challenged in new ways and if the curriculum is to be rewarding, it must be dynamic and meaningful. Our concept of using technology to connect components of the curriculum helps relate school-based studies to real-life experiences.

We are also bringing experts into the classrooms via videoconferencing technology. Two videoconferences were held last spring with a structural engineer at Parsons Brinckerhoff in New York City and our sixth graders who were involved in a mathematics unit on bridge building. Those sixth graders also enjoyed a videoconference with students in Northern Ireland involved in a bridge building activity. Activities such as these require careful analysis, preparation, and evaluation by the teachers involved ensuring that the two-way video and interactive medium adds value to the curriculum. In addition to the specific enrichment benefits of each project, we have observed that the prospect of a distance learning activity heightens enthusiasm, motivation, and zeal for learning, thus contributing to a more meaningful and effective school experience. The interactive component of distance learning is central to its effectiveness. The medium enables students to ask questions and share ideas with the instructor and others in what appears to students as a less threatening environment. Although research is needed to understand this phenomenon, it appears that the combination of adults and students participating in the discussion, and the impact of looking through a "big TV," heightens attention and interest levels. One benefit of this format is that as problems are posed and answered through dialogue, interpersonal communication skills are practiced and perfected.

Videoconferencing also provides benefits for professional development. The professional staffs of Mantua Elementary and Mantua Center have been utilizing two-way interactive distance learning to stay abreast of current research and applications within the field of education. Our objective is to establish a consortium to implement a model in which networked technology infrastructures and multimedia materials are used to research, identify, develop, evaluate, and disseminate innovative curricula and teaching strategies among K-6 classrooms. This model focuses on technology training and integration that not only improves classroom instruction, but extends learning beyond school walls. Among the strategies to be used in this endeavor are:

1) use of two-way interactive distance learning (IDL) subsystems to disseminate university level classes;
2) use of the network to facilitate teacher "sharing" and model technology classroom demonstration sessions;
3) on-site, customized staff development;
4) in-house training by peer practitioners;
5) workshop attendance and mini sabbaticals to develop new curricula and teaching methods incorporating IDL and other multimedia technologies;.

One of our first projects was a weekly graduate level class from James Madison University. The course enabled speech pathologists employed in the Northern Virginia area to take a mandatory course without having to drive several hours to and from class each week. In addition, the Distance Learning Center has provided cost-saving opportunities for professional conferences. For example, audiologists from Mantua and Fairfax County Public Schools held a videoconference with audiologists from Oakland County, Michigan to discuss recent innovations in the delivery of services to deaf and hearing-impaired clients. Last June, a graduate cohort sponsored by Fairfax County Public Schools Media Services Department attended a class titled *Distance Learning Technologies* presented by the Mantua Distance Learning Center Director, Sarah Skerker. We are beginning an ongoing dialogue about the utilization of information and communications technologies in the classroom with Ireland and other members of the Northeastern European Library Board (NEELB).

Mantua Center enjoys a partnership with Gallaudet University (funded by the Knight Foundation) that provides financial support to under represented populations such as deaf and ethnic minorities to complete graduate studies to become teachers of the deaf. This partnership, Project ACHIEVE, involves a relationship among five schools: Maryland School for the Deaf, Pennsylvania School for the Deaf, Kendall Demonstration Elementary School, Model Secondary School for the Deaf, and Mantua Center. The interactive distance learning capability at our site promotes ongoing staff development through dialogue with these centers as well as through participation in graduate courses, videoconferencing, and workshops offered by Gallaudet University. The program, facilitated by our distance learning technology, minimizes much of the isolation that is so often experienced by educators of the deaf.

Very early in our transition to a technology-rich instructional environment, we realized that: (1) providing teachers with technology without training simply doesn't work; and, (2) if teachers are to become comfortable with technology, they must use it daily in a supportive environment. Training our professional staff is an imperative. Our professional development goal is that all teachers and professional staff will develop confidence and competence in the use of instructional tools and specific strategies for providing effective, quality learning in the interactive distance learning environment.

The Role of Closed-Circuit TV:

The Tandberg Educator 5000 is used in combination with a professional studio camera and audiovisual equipment to create a closed-circuit television studio. From the Distance Learning Center, students produce and broadcast a daily news show, *Good Morning Mantua*, which is viewed in every classroom via a dedicated closed-circuit channel. The program segments include news, interviews, important daily announcements, and the popular *Sign of the Day*.

The *Sign of the Day* helps the hearing community learn the basics of American Sign Language from members of the Mantua deaf population and interpreters. This segment has a substantive impact on building a strong school community. Hearing students use the signs they learn to communicate directly with their deaf classmates and hearing teachers have commented how the exposure to rudimentary signing has helped them appreciate the complexity of challenges faced by Deaf and Hard of Hearing in our society.

The *Good Morning Mantua* show provides the opportunity for students to learn about being a news anchor or a member of a TV tech crew. Students prepare scripts and props, conduct the interviews, run the cameras and support equipment, operate the special effects generator and tape decks, monitor and select camera angles, and direct the broadcast. Students are trained in the various skills they need and then rotate for a week at a time to provide an opportunity for as many students as possible to participate in this activity.

The closed-circuit TV studio is also used in conjunction with the Distance Learning Center's interactive computer instruction capabilities to deliver internet-based and distance learning activities to other classrooms.

Video Production:

The Mantua Distance Learning Center includes modest capabilities for digital and analog video production. Video is a form of communication that takes into account visual, auditory, and kinesthetic learners' needs providing students with a popular and effective method of disseminating learned information. The video production capabilities are used to support group and individual projects.

A student team captured a second prize in a countywide video competition for their documentary on how to produce the *Good Morning Mantua* show. The students wrote the script, acted, produced and directed the documentary. The team then edited the video and prepared the final tape. Students have used the video production facilities to prepare videos of plays written as final products for literature circle activities. Others have used the production capabilities for storytelling performances. We are especially excited about the creation of videos designed to enhance language acquisition for our students who are deaf and non-English-speaking.

Digital video production has been used primarily to support staff presentations at national and international conferences. This year we will begin to use this capability to support student projects.

Interactive Computer Instruction:

The Distance Learning Center's rear-projection SMARTBoard maximizes classroom effectiveness by allowing teachers and/or students to run a variety of multimedia from a single location on a large, easily visible, touch-sensitive screen. Key topics can be highlighted, notations can be made over computer images, and the entire body of work can be saved to a computer file then printed, emailed, or posted to a network. This electronic whiteboard is an effective tool for whole-group Internet, software application, and curriculum-based instruction.

Students have used the large visible screen of the SMARTBoard to advantage in conducting group research, preparing and giving group presentations.

Summary

Mantua Elementary and Mantua Center are committed to extending educational experiences beyond the classroom and to creating a distributed learning environment that allows all students and teachers to be active participants in the educational process. We believe strongly that technology is the key to equalizing educational opportunity, achieving excellence, and preparing effective citizens of the twenty-first century.

Web Research July 25, 2000

Japanese Education: A Comparative View

1. Turn on your computer, open your Web browser.
2. **Do you know how to evaluate Web materials?** (Group discussion)

3. With your partner, write your ideas in this box – it is only a draft, your ideas will grow: **Here are some ideas we talked about in class:** uniforms, schedule, school year, textbooks, technology, and public vs. private… what other topics?

IDEA BOX….			
		In Japanese schools…	In U.S. schools…
Which Ideas or Questions do you Want to Pursue?			
Food…[For example]		[For example] Students bring lunch from home in an "obento" box, often made by their parents.	[For example] Students will buy food in the cafeteria, or sometimes bring it from home in a bag.

4. As you use search engines like Ask Jeeves and others, please experiment with different key words. How does a search using the term "Japanese classroom" compare with a search using the term "Japanese school"? (Write your answer on the back of this paper) .

5. **Treasure Hunt:** Please find an example of each of these……(Check the box when you find it)

☐ A government document written about Japanese education
☐ A Japanese school Web page in English
☐ A US school Web page (for comparison)
☐ A site that describes the school day or year comparing to the US schedule
☐ A dictionary or encyclopedia entry related to this project
☐ Writing by a Japanese student, in English, online
☐ A picture, online, of a Japanese classroom

6. Please get ready to draft a plan within your group by free writing in your journal.

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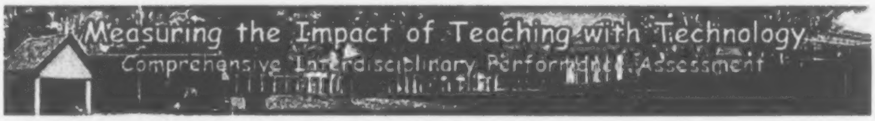
Measuring the Impact of Teaching with Technology
Comprehensive Interdisciplinary Performance Assessment

Annotated Bibliography: Select Articles Regarding Learning, Performance Assessment & Educational Technology

By Laura Blasi ,
The University of Virginia,
Curry School of Education
Center for Technology and Teacher Education

August, 2000

Policymakers have been asking educators to demonstrate the impact of technology upon teaching and learning. Traditionally, this has been done using standardized test scores which measure student retention of subskills. As technology changes the way we teach and learn, we need to think of new ways to evaluate teaching and learning.

This bibliography was created in response to the question: "How can performance assessments be used to measure the impact of technology on learning?" It was written with practitioners in mind. While we turn to performance assessment when attempting to evaluate the impact of technology upon teaching and learning, we also need to ask if new tools will be needed to make this approach to evaluation feasible.

We offer a collection of resources – books and Websites – for practitioners specifically interested in implementing performance assessments while using educational technology. In the bibliography we summarize some of the findings and researcher recommendations made regarding performance assessment, conveying some of the findings and cautions in the current literature. We have not exhausted the literature, but instead have arranged key pieces thematically, moving from practice-based issues to policy-based issues.

While this was written with teachers in mind, the first half of this bibliography should also be of interest to instructional designers (including developers of software-based assessment and educational multimedia programs). The first eight citations outline learning strategies, explaining how they can be taught and how they can be evaluated in relation to developing technology-integrated performance assessment.

Problem-based learning, reflective problem solving, and learner self-regulation, can be used within performance assessment, while integrating technology into teaching and learning. Moving from technology in teaching to technology in assessment, Kelly-Benjamin (1995) and McNabb and Smith (1998) offer insights into ways technology could help teachers develop and record

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performance assessments.

The second half of this bibliography offers insights into the more technical aspects of performance assessment. Linn (1994), Messick (1994), and Herman (1997) offer comprehensive overviews of performance assessment in relation to issues of validity and replicability. The authors emphasize the need for careful specification procedures,

multiple samples of student performance, and attention toward discriminant evidence toward establishing validity.

The need for developmental sensitivity is raised, as authors caution against basing the performance assessments upon the student goal of mimicking adult roles and capabilities. Authors also caution against teaching students to perform, urging cosmetic expertise at the expense of the development of habits of learning, which include taking risks, acknowledging limitations, mistakes, and areas of further development. Assessments structured around "tasks," instead of "constructs" (such as student comprehension), risk returning to behavioralistic educational approaches.

Several of the authors urge the documentation of unintended consequences stemming from the specific tasks, as processes and outcomes may vary from the construct the teacher is seeking to measure. Unintended consequences also need to be documented as they arise from the approach to assessment. A teacher using a writing prompt to indirectly measure student editing skills, for example, may begin to emphasize student practice with prompts, without teaching specific editing skills or the process of revision.

This bibliography takes a critical approach to performance assessment. Burdens felt by teachers and discomfort felt by parents are described by several of the authors. Performance assessment often calls for k-12 schools to compensate for the lack of training available for preservice teachers (in post-secondary education schools) regarding performance-related instructional methods and approaches to assessment.

In-service teachers, currently in the classroom, also work within conditions that can be adverse to performance assessments. Teachers using both standardized testing and performance assessments are often left to negotiate the potentially conflicting teaching methods and educational goals. Students are left to resolve the repercussions from the conflicts on their own. As teachers face a lack of available time, among other challenges, the k-12 school system stands to be held back by the mismatch between the norms of the U.S. teaching culture and the collaboration demanded by increasing use of performance assessment and portfolios. This mismatch will make it difficult to implement some of the approaches that increase reliability and generalizability described within this bibliography.

Within this bibliography, we have taken care to keep in mind that, as Baker and O'Neil (1996) have eloquently stated, "performance-based assessment is obviously grounded in a different instructional model, one for which the majority of teachers of disadvantaged children may be unprepared" (p. 185). As teachers at Mantua Elementary seek to differentiate instruction and assessment, to meet the needs of all of their students, they do so with the intent of using technology to meet individual learner needs.

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Measuring the Impact of Teaching with Technology
Comprehensive Interdisciplinary Performance Assessment

Measuring the Impact of Teaching with Technology: Brief Narrative and Video Clips (with Transcripts)

{video links will be uploaded shortly}

These five clips provide overview text regarding the use of technology for teaching and learning at Mantua Elementary School. The clips and questions can be used with teachers, preservice students, and by evaluators within small groups discussions. the clips allow the teachers and students to speak for themselves, and they allow you a glimpse into the classrooms.

The video links are embedded, but you may have to download a copy of real video player to view them. Because this technology is not always accessible, we are including transcripts of each clip at the bottom of each page. The site also includes a number of PDF-format documents.

Get Acrobat Reader realplayer FREE

Discussion Questions:

1. What other incentives are available for teachers as they become interested in incorporating technology into their teaching in meaningful ways?
2. What are other parental concerns and how do their concerns correspond to feedback gained through standardized testing?
3. After reviewing these clips, how would you evaluate the student process and performance?
4. Is it possible to teach and learn using technology, while thinking critically about technology?
5. From your experience, what are the positive and negative effects of technology on teaching and learning?

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Survey created by Blasi (blasi@virginia.edu) and Heinecke (heinecke@virginia.edu)
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August, 2000

Teacher Inventory

This survey is being administered to faculty, pre-service, and in-service teachers, specialists, administrators, and interpreters, to create a collective snapshot of backgrounds, perceptions, and attitudes in U.S. education. The information you share here will be reported to the Department of Education, as they seek to understand the current conditions educators face. All responses will remain confidential, and individual responses will not be shared with others in your school, or within reports created from this survey.

Date: ___/ ___/ 2000 **School or site name**: ___________

Location (city, state): ________________________________

Last four digits of Social Security number: ___ ___ ___ ___

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1. The following paragraphs describe an observation of Ms. Hill and of Mr. Jones. Please check the box that best answers each question for you.

Ms. Hill was leading her class in an animated way, asking questions that the students could answer quickly; based on the reading they had done the day before. After this review, Ms. Hill taught the class new material, again using simple questions to keep students attentive and listening to what she said.

Mr. Jones' class was also having a discussion, but many of the questions came from the students themselves. Though Mr. Jones could clarify students' questions and suggest where students could find relevant information, he couldn't really answer most of the questions himself.

	Definitely Ms. Hill's	Tend towards Ms. Hill's	Can't decide	Tend towards Mr. Jones	Definitely Mr. Jones
a. Which type of class discussion are you more comfortable having in class?........	☐	☐	☐	☐	☐
b. Which type of discussion do you think most students prefer to have?..........................	☐	☐	☐	☐	☐
c. From which type of class discussion do you think students gain more knowledge?...............	☐	☐	☐	☐	☐
d. From which type of class discussion do you think students gain more useful skills?	☐	☐	☐	☐	☐

2. Teachers have described very different teaching philosophies when interviewed by researchers. For each of the following pairs of statements, check the box that best shows how closely your own beliefs are to those in a given pair. The closer your beliefs are to a statement, the closer the box you check. Please ✓ only one for each set.

a.	"I mainly see my role as a facilitator. I try to provide opportunities and resources for my students to discover or to construct concepts for themselves."	☐	☐	☐	☐	☐	"That's all nice, but students really won't learn a subject unless you go over the material in a structured way. It's my job to explain, to show students how to do the work, and to assign specific practice."
b.	"The most important part of instruction is the content of the curriculum. That content is the community's judgment about what children need to be able to know and do."	☐	☐	☐	☐	☐	"The most important part of instruction is that it encourage 'sense-making,' or thinking among students. Content is secondary."
c.	"It is useful for students to become familiar with many different ideas and skills even if their understanding, for now, is limited. Later, in college, perhaps, they will learn these things in more detail."	☐	☐	☐	☐	☐	"It is better for students to master a few complex ideas and skills well, and to learn what deep understanding is all about, even if the breadth of their knowledge is limited until they are older."
d.	"It is critical for students to become interested in doing academic work – interest and effort are more important than the particular subject-matter they are working on."	☐	☐	☐	☐	☐	"While student motivation is certainly useful, it should not drive what students study. It is more important that students learn the history, science, math and language skills in their textbooks."
e.	"It is a good idea to have all sorts of activities going on in the classroom. Some students might produce a scene from a play they read. Others might create a miniature version of the set. It's hard to get the logistics right, but the successes are so much more important than the failures."	☐	☐	☐	☐	☐	"It's more practical to give the whole class the same assignment, one that has clear directions, and one that can be done in short intervals that match students' attention spans and the daily class schedule."

3. Different cultures intersect within our schools – including different socio-economic backgrounds, different races, religions, and ethnicities. Read the following statements carefully, and please check the box closest to the statement that represents your experience within your school community where you are teaching. Please ✓ only one for each set.

There are limitations regarding access to technology for parents and children whose cultures are different from my own culture, in my local school community.	☐ ☐ ☐ ☐ ☐	Parents and children who are from my culture face greater challenges regarding technology access than those in other cultures, within my local school community.
There are deficits regarding the development of capabilities felt by parents and children whose cultures are different from my own culture, in my local school community.	☐ ☐ ☐ ☐ ☐	Parents and children who are from my culture face greater challenges regarding the development of capabilities than those in other cultures, within my local school community.

4. Within your school in the past 6 months have you discussed...

a. Why technology is being incorporated into your classroom? ☐ yes ☐ no
b. Why you are working with particular software/ hardware? ☐ yes ☐ no
c. Teaching in your content area (with or without technology)? ☐ yes ☐ no
d. How technology can be used to teach in your content area? ☐ yes ☐ no
e. Your colleagues' experiences using technology? ☐ yes ☐ no

5. How would you characterize yourself? (please choose only one)

☐ Risk-taker in regard to new technologies, eager to try
☐ Deliberative, but willing to try new technologies
☐ Skeptical and cautious regarding new technologies
☐ Suspicious of new technologies, unlikely to try them

6. Read the following statements carefully, and please check the box closest to the statement that represents your beliefs about teaching with technology. ✓ only one.

If I use technology it will determine what I teach and how I teach, because of the types of activities available and the location and set up of our computers.	☐ ☐ ☐ ☐ ☐	Technology is a tool that I use in the classroom or lab when it serves my lesson planning objectives. My goals determine how it will be used, and for which purposes.

7. Which best describes your use of computers in instruction? Choose one only.

- ☐ Computers are rarely to never used
- ☐ Computers are used occasionally, for some lessons during the semester
- ☐ Computers are used intensively, but only for certain lessons during the semester
- ☐ Computers are used throughout the semester, but not every class session
- ☐ Computers are used nearly every class session

8. A student in your classroom has trouble staying focused, and seems to need a lot of structure in order to complete an assignment. How would you use technology, while teaching this student who has also been identified as a "low achiever"? There are no "right" answers, but please explain your approach, whether or not you decide you could (and should) incorporate technology. (Feel free to use the back of this page...)

9. You have been asked to teach specific content to your students with technology – to demonstrate to an observer that technology can be used to teach in ways not possible in the "traditional" classroom. What would you do? There are no "right" answers, but please specify content, age and grade of students, and describe your approach. (Feel free to use the back of this page...)

10.

The Use of Technology in Classroom Instruction:

Please indicate how often you use technology for these purposes (check only one box for each statement, using the key below)

		Purposes....	1	2	3	4	5
a.		Preparing word processed lesson plans					
b.		Using software, or spread sheets for grading					
c.		Developing lesson plans that use software					
d.		Accessing lesson plans from the Web					
e.		Accessing information from the Web					
f.		Accessing information from CD-ROMs					
g.		Communicating with others via listservs					
h.		Communicating with others via email					
i.		Communicating with others via videoconference					
j.		Developing individual or group presentations					
k.		Creating web-pages for instruction					
l.		Developing multi-media presentations					
m.		Developing lesson plans using spreadsheets and databases					
n.		Developing lessons that use technology tools such as the digital camera and scanner					
o.		Preparing lessons that use a display system (for example, a TV connected to computer).					
p.		Using software with students to prepare for standardized tests, to practice for taking them.					
q.		Using software that has students practice skills (such as choosing the correct word, or the solution to a math problem)					
r.		Using computer programs as tools for students to create with, such as Kid Pix or a drawing program.					

1 = never
2 = rarely (once or twice a term/ semester)
3 = occasionally (once or twice a month)
4 = frequently (every week)
5 = often (almost every day)

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11.

Computer Training... Please indicate your experience with the following computer skills/applications. Formal training may include professional development workshops, Academy Classes, collegiate courses and professional conferences. Please select one choice for each category.

	Experience	1	2	3
a.	Word Processing Programs			
b.	Database Programs			
c.	Spreadsheet Programs			
d.	Graphics Programs			
e.	Telecommunications (Email, Internet, etc.)			
f.	Web Authoring (html)			
g.	Multimedia Programs (HyperStudio, KidPix)			
h.	How to integrate computers into existing lessons			
i.	How to organize activities to allow for computer use during class time			
j.	How to manage your class in a lab			
k.	How to use technology in a one-computer classroom			

1=Have Not Yet Learned 2=Learned on My Own 3= Learned with Formal Training

12.

I am able to do this.... The following statements list various activities. After each please indicate the extent to which you feel you are able to do these activities.

1=Definitely 2=Probably Could Do This 3=Unsure 4=I Don't Think So 5=Not Able

	Activities	1	2	3	4	5
a.	Selecting technology resources for my students					
b.	Implementing technology resources for my students					
c.	Incorporating the Web into instruction					
d.	Incorporating E-mail into instruction					
e.	Incorporating videoconferencing in instruction					
f.	Developing computer-based classroom presentations					
g.	Using e-mail and the Internet with individuals or small groups					
h.	Using computers in many settings (in classroom, lab, etc.)					
i.	Teaching students select/ use technology appropriate to task					
j.	Teaching search strategies for Internet and CD-ROMs					
k.	Teaching students to use electronic encyclopedias					
l.	Teaching students to manage information using spreadsheets and/or databases					
m.	Teaching students using GIS (Geographic Information Systems)					
n.	Teaching students using the graphing calculator					
o.	Teaching students using a VCR					
p.	Teaching students using an overhead projector (OHP)					

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13.

Obstacles to Technology Integration...

Rank the following obstacles according to your experiences.

1= obstacle that least inhibits my use of technology
5= obstacle that most inhibits my use of technology

		1	2	3	4	5
a.	Lack of knowledge about computers and computer software					
b.	Lack of expectations for classroom use by school leaders					
c.	Lack of training					
d.	Lack of time to change practice					
e.	Lack of access to technology resources					

(you should have only one ✓ in each numbered column)

Other obstacles:

14. Methods Matrix: What is Your Level of Confidence/ Experience?

Please check 4 two boxes
(one for confidence, one for experience) for each method listed.

1=I am very confident that I could do this
2=I am somewhat confident
3=I am not at all confident

1=I have a lot of experience
2=I have some experience
3=I don't know what this is

	Confidence				Experience		
	1	2	3	Methods...	1	2	3
a				Lecture, formal/ informal			
b				Lecture, commentary (on an article, etc.)			
c				Cooperative learning (i.e. jigsaw, STAD)			
d				Collaborative learning			
e				Group problem-solving (i.e. think-pair-share)			
f				Peer teaching			

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2=I am somewhat confident	2=I have some experience
3=I am not at all confident	3=I don't know what this is

	Confidence				Experience		
	1	2	3		1	2	3
g				Modeling cognitive processes (DRTA, KWL, think-alouds)			
h				Simulation/ role play			
i				Problem-based/ inquiry-based learning			
j				Student presentations (speaking)			
k				Synthesis/ analysis			
l				Advance organizer			
m				Question and answer (diagnostic, developmental, informational)			
n				Learning sets/ Objectives (Hunter)			
o				Word maps/ concept mapping			
p				Recitation			
q				Drill (preparatory, review, remedial)			
r				Cloz passage, fill-in-the-blank			
s				Scavenger Hunts			
t				Word Problems			
u				True/ False, Matching, Multiple choice			
v				Worksheets			
w				Manipulatives (blocks, models)			
x				Study (independent, supervised)			
y				Listing, grouping, and labelling (Taba)			
z				Guided Practice/ Independent Practice			
aa				Teams-Games-Tournaments (TGT)			
bb				Demonstration			
cc				Effective data display			
dd				Discussion (interactive, introductory, clarification, summary)			
ee				Listening (active, deliberate, empathetic)			
ff				Decision-making models			
gg				Map and globe use			

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	Confidence				Experience		
	1	2	3		1	2	3
hh				Concept formation			
ii				Primary source use			
jj				Biography production			
kk				Using children's trade books			
ll				Field trips			
mm				Community/ local resources			
nn				Laboratory experiments			
oo				Hypothesizing			
pp				Data Gathering			
qq				Generalization			
rr				Journaling			
ss				Research Paper			
tt				Debate			
uu				Use of activity "centers"/ learning stations			
vv				"Free" time			
ww				Portfolio development			
xx				Workshop			
yy				Visualization			

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15. Methods and Technologies Matrix: Which Work Best Together?

Teaching Methods

After skimming through all of the teaching methods listed in the left column, please write numbers beneath the technologies indicating your use of the technology, while using the method (respond even if you are in a non-classroom teaching position now, as, for example, a specialist).

1 = always use it
2 = sometimes
3 = rarely
4 = never

0 = not applicable

	Teaching Methods	Word processing	VCR	OHP	T.V.	E-mail	Web research	Online archives	Drill/ Task Software (e.g. Reader Rabbit)	"Tool" Software (e.g. Geometer Sketch Pad)	"Living Books"	Presentation (e.g., Power Point)	Spread sheets	Database	Video conferencing	Video (filming, editing)	CD-ROMs	Multimedia programs (e.g., Hyperstudio)	Handheld technology (graphing calculator)	GIS (Geographic Information Systems)
a	Lecture, formal/ informal																			
b	Lecture, commentary (on an article, etc.)																			
c	Cooperative learning (i.e. jigsaw, STAD)																			
d	Collaborative learning																			
e	Group problem-solving (i.e. think-pair-share)																			
f	Peer teaching																			
g	Modeling cognitive processes (DRTA, KWL, think-alouds)																			
h	Simulation/ role play																			
i	Problem-based/ inquiry-based learning																			
j	Student presentations (speaking)																			
k	Synthesis/ analysis																			
l	Advance organizer																			
m	Question and answer (diagnostic, developmental, informational)																			

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n	Learning sets/ Objectives (Hunter)																			
o	Word maps/ concept mapping																			
p	Recitation																			
q	Drill (preparatory, review, remedial)																			
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y	Listing, grouping, and labelling (Taba)																			
z	Guided Practice/ Independent Practice																			
aa	Teams-Games-Tournaments (TGT)																			
bb	Demonstration																			

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c c	Effective data display																			
d d	Discussion (interactive, introductory, clarification, summary)																			
e e	Listening (active, deliberate, empathetic)																			
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n n	Laboratory experiments																			

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p p	Data Gathering																			
q q	Generalization																			
rr	Journaling																			
s s	Research Paper																			
tt	Debate																			
u u	Use of activity "centers"/ learning stations																			
v v	"Free" time/ Unscheduled time																			
w w	Portfolio development																			
x x	Workshop																			
y y	Visualization																			

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17. Please check √ the scenario that best fits your own perspective at this time (Please only check one)

a. Sarah Cohen is familiar with the technology currently being used in her classroom and in the lab, but she has found an alternative approach to using technology that she wants to explore further.		
b. Focused on collaborating, Fred Roy has been sharing lesson plans and ideas gathered from conferences, while cooperating with his colleagues in terms of scheduling and the use of technology resources.		
c. Scrutinizing the effects of information technologies (IT) on her students, Maria Suarez focuses on her students' outcomes, as well as their performance in class, and the competencies they attain.		
d. Most important to Bill Kitano are issues related to organizing his lessons using technology, and managing the class, while he seeks the most efficient and effective use of information and resources.		
e. With partial confidence, Demario Sava uses technology when there are few conflicts with his own priorities. He drops technology aside to help his students prepare for tests. Status of IT among administrators and incentives for teachers influence how often he uses technology.		
f. Interested in using technology in her lessons, Sue Delmonico has heard about how her colleagues use the lab, and she would like to know more about how a computer could fit into her current lessons.		
g. Absorbed by his role on a budget committee, while adopting a new text book, Ted Blade has not turned his attention to the use of technology in his classroom.		

18. Concerns I have regarding the use of technology in my classroom....

(Please rank the four following statements from 1-4, with 1= the most important)

a. Right now I have concerns that have little or nothing to do with technology; there are several matters in and/or outside of school that require all of my attention.		
b. I am concerned with increasing my own understanding of how to use technology. I am influenced by how the use is perceived by others in the school. At this point in time, technology is something I may or may not use while teaching.		
c. Specific tasks using technology concern me – I choose these tasks mindful of the use technology as it fits in my schedule and with my teaching goals.		
d. The impact of technology on teaching & learning is a concern for me; my concern focuses on benefits felt by the school community and/or on changes seen within my own students.		

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19. Considering the 1999 - 2000 school year please rank the role, if any, the following people played in your use of technology in your classroom:

If you are a new teacher, check "yes" and move on to the next question. Yes, these people did not play any role for me, I am a new teacher at Mantua......	☐ Yes

		Please place numbers from 1-3 next to each person's name, with 1 = the response they would most likely have; or mark the last column (had no role) and move to the next person.			
		I want to respond to your needs, and make sure you have the supplies and anything else you need. My goals were developed from district-level priorities.	I will initiate new staff development practices or policies. I am encouraging when you are less involved or have little energy. I have long range goals in mind.	I keep our activities flowing, managing over a length of time. I often solve problems as needed. I am often planning for instructional needs, and I am sensitive to the needs of teachers.	This person had no role in my use of technology.
a. Ellen Schoetzau					
b. Jay McClain					
c. Jan-Marie Fernandez					
d. Elizabeth Lertora					
e. Sarah Skerker					
f. Pat Small					
g. Kathy Bressner					
h. Jill Rodriguez					

20. Which racial/ ethnic group(s) do you identify with? (Please check as many as apply)

☐ African-American ☐ Asian-American ☐ Caucasian/ White ☐ Hispanic or Latino/a
☐ Native American/ Pacific Islander ☐ Other, please specify ___________

21. Gender ☐ Female ☐ Male

22. What is your age?
☐ 20-30 ☐ 31-40 ☐ 41-50 ☐ 51-60 ☐61-70 ☐ 71+

23. Current Teaching Status:

- ☐ Pre-service teacher (with prior classroom experience)
- ☐ Pre-service teacher (without prior classroom experience)
- ☐ Currently a classroom teacher (uncertified)
- ☐ Currently a classroom teacher (certified)
- ☐ Instructional assistant
- ☐ Administrator
- ☐ Interpreter
- ☐ Specialist (PE, Music, Art,...) Specialty: ___________________
- ☐ Specialist (Itinerant) Specialty: ___________________

Only answer the following question if you checked "Currently a classroom teacher" (within question 23). If you are not currently a teacher, please skip to question 25.

24. a. How many years have you been in your current position?
☐ 0-2 ☐ 3-5 ☐ 6-10 ☐ 11-15 ☐ 16 or more

b. What grade do you teach?
☐ K ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6
☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐ 11 ☐ 12
☐ Computer Lab (across grades)
☐ Resource teacher (across grades)
☐ Other________________________

c. Have you worked with a preservice teacher before? ☐ Yes ☐ No

d. If yes, what was your experience like, overall? ☐ Positive ☐ Neutral ☐ Negative

e. How many years have you been a K-12 teacher?
☐ 0-2 ☐ 3-5 ☐ 6-10 ☐ 11-15 ☐16 or more

25. Most recently completed educational degree...

☐ BA/BS ☐ MA/ MS ☐ Five year degree (combined BA/MA)
☐ Ph D ☐ Ed D ☐ Other (specify) _____________

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All responses are confidential. Thank you for participating in this survey.

Creating Practical Evaluation Templates for Measuring the Impact of Instructional Technology

Prepared by
Interactive, Inc.
For the
North Central Regional Educational Laboratory

July 2000

Contents

Executive Summary

Purpose of This Report
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  - Goals

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  - Infusion Into Schools
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  - Measurement Tools
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Recommendations for Using Measurement Tools
  - Prioritize Goals and Issues/Questions
  - Consider Demands on Teachers and Students
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  - Timing

References

Appendices
  - Reference Sources for Original Measurement Instruments
  - Audit Survey
  - Teacher Survey
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Executive Summary

During the academic year 2000-2001 the Montgomery County (Maryland) Public Schools (MCPS) is partnering with the North Central Regional Educational Laboratory (NCREL) in initiating the *Literacy Through Technology* project, a K-3 program aimed toward producing positive attitudes and skill development in students' reading and writing. *Literacy Through Technology* is part of the MCPS technology plan known as the *Global Access* project, a multiyear initiative in which technology is an essential tool for teaching, learning, and management.

Evaluation of technology implementation and the relation between technology use, student learning, and achievement requires appropriate measurement tools. Interactive, Inc., has been contracted to develop such instruments, under agreement with NCREL. Reflecting the current literature on effective technology use in the classroom, the Interactive, Inc.-developed instruments measure four domains of computer implementation and use across three instruments/reporting sources. The four domains are as follows:

- Technology infrastructure
- Teacher preparation
- Teaching strategies
- Student use patterns

The three reporting sources are as follows:

- Teachers
- Students
- School administrators (or other personnel responsible for technology census data)

In addition to providing measures for use by MCPS, this report also includes recommendations and considerations in choosing and using those measurement tools and measurement tools in general.

Purpose of This Report

Background

The North Central Regional Educational Laboratory (NCREL) is a not-for-profit organization committed to developing and testing technology-based educational innovations. NCREL's work is performed through partnerships with school districts. One such partner district is the Montgomery County (Maryland) Public Schools (MCPS).

During the academic year 2000-2001, MCPS is initiating the *Literacy Through Technology* project, a K-3 program aimed toward producing positive attitudes and skill development in students' reading and writing. *Literacy Through Technology* is part of the MCPS technology plan. The technology plan is known as the *Global Access* project, a multiyear initiative to equip and connect all MCPS classrooms, media centers, and offices with computers. The infrastructure of wiring, hardware, software, and training represents a vision in which technology is an essential tool for teaching, learning, and management. Key features of the technology plan include:

- Wiring early childhood classrooms for LAN, WAN, and Internet connections to provide easy access to local and global information sources for teaching, learning, managing, and supporting instruction.
- Each classroom will have six drops and a minimum of five computers per classroom, aimed toward a student-to-computer ratio of 3:1.
- School networks will be loaded with instructional software supporting the development and extension of students' skills in reading and writing.
- Teachers and specialists will be provided with instructional applications and training opportunities that will facilitate infusion of technology into instruction. The intention of training and application is to transform classrooms into student-centered, inquiry-based models supported by current technology.

MCPS wishes to test the value added to student achievement by inclusion of technology into their reading initiative. A preliminary and integral step to such tests is identification and selection of instrumentation through which technology implementation and use can be measured. Interactive, Inc., has been contracted by MCPS to advise them on how to proceed with their measurement decisions.

Goals

There are two general goals for this report. The first is to serve MCPS's effort to conduct an internal evaluation of the relation between classroom technology use and student achievement outcomes. The second is to do so in a manner that provides a template for making measurement/ instrumentation decisions relevant to technology implementations beyond *Literacy Through Technology*.

In addition, there are two specific goals that follow from the general goals and background of this report:

- To provide a briefing on the major concepts that cross previous efforts to measure technology use in the classroom
- To provide a measurement instrument that addressed those major concepts, which can be used for measuring classroom technology use

Technology in the Classroom

Infusion Into Schools and Conditions for Success

The penetration of technology into the classroom has become a fact of educational life. There has been a marked increase in the availability of computers to students in the United States, from one computer for every 125 students in 1983 (Glennan & Melmed, 1996) to one computer for every 5.7 students in 1999 (Education Week, 1999). By 1998, 93 percent of teachers in Grades 4-12 were using computers for professional purposes. In addition, 71 percent of teachers assign computer work to their students at least occasionally (Becker, Ravitz, & Wong, 1999).

Further, there is accumulating evidence that computers and related technologies can be effective tools for improving student learning and achievement when utilized systematically (Schacter, 1999; Wenglinsky, 1998). Such uses include support for individual learning (e.g., in skills drills, using the Internet, and word processing), for group learning (e.g., in presentation software and collaborative communication), and for instructional management (e.g., in integrating standards and assessments and in coordinating and integrating lessons) (Becker, Ravitz, & Wong, 1999; Wenglinsky, 1998).

However, we now know that the allocation (or presence) of computing and technological resources does not equate to successful utilization and learning benefits for students. Indeed, it is only when programs are well implemented that positive effects on learning and achievement can be expected (Collis, Knezek, Lai, Miyashita, Pelgrum, Plomp, & Sakamoto, 1996; Knapp & Glenn, 1996).

Implementation quality depends on a combination of adequate technical resources, teachers being well trained in application strategies and techniques (Anderson & Ronnkvist, 1999; Becker, 1998), and student engagement in using the technology (Hickey, 1997).

In short, technology in the classroom only translates into learning and achievement gains when the hardware and software are appropriate to program objectives, teachers are trained in—and follow through on—applying the technology to curricular and learning goals, and students "buy in" to using computers as learning devices.

Measuring Allocation and Utilization

The research literature on the conditions for successful employment of classroom technology (as described above) indicates the need to measure four key domains in order to (a) understand the allocation of technology resources and their utilization patterns and (b) predict student outcomes from those allocation and utilization patterns. These four domains are as follows:

- *Infrastructure*, which refers to the availability of technology resources (hardware, software, connections) to teachers and students. Key considerations are provision and maintenance of up-to-date computers and connections, numbers of computers (as well as ratios of students to computers), technical support, software availability, and ease of access to both hardware and software.
- *Teacher preparation*, which refers to training in basic and creative uses of technology for instructional purposes. Key considerations include developing expertise in applications (e.g., word processing, graphics), ability to instruct students on the use of those applications, and understanding how to integrate technology and curriculum.
- *Teaching strategies,* which refers to two interrelated strategic areas. One area is integration of technology applications into student learning activities. Key considerations include the use of technology as providing resources for instructional support (e.g., locating information and programs through the Internet and networks) and as a medium for instruction (e.g., drills). The other area is pedagogical style. The key consideration is the degree to which the teacher is "instructivist" (i.e., treats learning as a process of students receiving knowledge) versus "constructivist" (i.e., treats learning as an active discovery process in which the teacher sets up experiences through which the students can generate deep understanding of curriculum). The former pedagogical style makes minimal use of technology while the latter maximizes the use of technological resources.
- *Student use patterns*, which refers to the technological activities in which students are engaged. One area is simply the amount of use or the proportion of time that a student is actively using a computer (as opposed to doing other things or being logged-on but not active). Another area is what the student is doing when he or she is actively using the computer. Key considerations include the types of connections (e.g., Internet, networks) and software programs being utilized.

The MCPS *Global Access* program is well conceived in that it explicitly addressing each of the four domains as a means to improve student learning and achievement. More specifically, the plan conceptually coordinates infrastructure availability and teacher preparation, and promotes teaching strategies valued as linkages between infrastructure/preparation and student use patterns.

The following section presents instruments designed to measure program performance in each of the four domains. These instruments are intended to assess the degree to which MCPS attains their program objectives.

Measurement Tools

For the purposes of documenting learning technology programs, numerous instruments have been developed by a variety of authors. Most instrumentation is necessarily specific to the particular intervention or program it was developed to measure.[1] However, a number of instruments have been developed that are relatively standard and applicable to virtually any learning technology evaluation.

---

[1] In fact, pursuant to the "Recommendations" section of this report, it is our belief that tailoring instruments to particular projects is absolutely necessary to capture or document the essence of the program as it is developed, implemented, etc.

The instruments included as appendices to this report are syntheses of a number of preexisting measures. The table below demonstrates the relationships between the four domains and the instruments. After that, we offer recommendations for using the instruments.

Table 1: How the Instruments Measure the Four Domains

Domain	Instrument	Concepts Measured	Questions/Location
Infrastructure	Technology Audit	Number and type of computers available for instructional use	Page 1 chart
		Location of computers used for instruction	Page 1 chart
		Number of computers available for administrative purposes	Page 1 chart
		Connectivity	Page 2 chart
		Types of software content and applications available	Page 3 chart
	Teacher Questionnaire	Number and type of computers available for instructional use	Section II, Question 6
		Location of computers used for instruction	Section II, Question 6
		Connectivity	Section II, Question 7
Teacher preparation	Teacher Questionnaire	Technology literacy	Section III, Questions 8-19
		Attitudes toward technology	Section IV, Questions 20-27
		Professional development received	Section VI, Questions 31-34
		Professional development needed	Section VI, Question 35
Teaching strategies	Teacher Questionnaire	Teaching style	Section V, Questions 28-30
		General computer use	Section VII, Questions 36-38
		Computer use by content area or application	Applications charts, pp. 13-14
		Curriculum integration	Section VII, Question 39
Student use patterns	Student Questionnaire	Attitudes toward computers	Questions 1-10, 25-30
		General school computer use	Questions 11-13
		School computer use by curriculum area	Questions 14-19
		General home computer use	Questions 20-24

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Standards

As a complement to the instruments included as appendices, a number of organizations have devised a set of standards by which an educational unit could judge or compare itself to others. These standards establish criteria for judging quality of teacher and student involvement with technology. The two most commonly cited sets of standards are:

- The CEO Forum School Technology and Readiness Report (STAR) Chart
- The International Society for Technology in Education (ISTE) National Educational Technology Standards (NETS) Project
    - NETS for Students: Connecting Curriculum and Technology
    - NETS for Teachers: Preparing Tomorrow's Teachers to Use Technology

Domain	Possible Measurement Standards
Infrastructure	CEO Forum STAR Chart
Teacher preparation	CEO Forum STAR Chart
Teaching strategies	ISTE Standards for Teachers CEO Forum STAR Chart
Student use patterns	ISTE Standards for Students

These standards are available online at www.ceoforum.org and www.iste.org for schools or districts to use as technology standards against which to evaluate a technology program.

Recommendations for Determining How to Use Measurement Tools

Prioritize Goals and Issues/Questions

In order to glean the knowledge necessary to make program and policy decisions, the research process requires a map linking goals (including understanding of program effects and possible action decisions), the information that needs to be obtained, and measures appropriate to providing that information. Such mapping gets conducted on a study-by-study basis. Put differently, effective evaluation research relies on critical thought and planning rather than on exercising cookie-cutters.

In the present case, we have worked from a general understanding of the MCPS *Literacy Through Technology* program structure and goals to provide a set of measures that are applicable to measuring the program as well as for more widespread use. However, we recommend that the program principles convene and reach agreement on their specific goals for evaluating the program, and apply those goals as a context for collecting and making sense of the data.

Such planning is recommended because it is necessary to ensure that the questions most important to MCPS are answered. Analogously, if you want to build a house, you start with a blueprint and then begin building. This process is necessary to winding up with a product that suits your specified needs. You would never start building without knowing the house design. Yet, there are many cases of well-intentioned and smart people collecting survey data and then

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beginning to think of their questions—and ultimately winding up frustrated with trying to form the raw materials into a structure that is coherent and suitable to their needs. Such coherence and suitability is the result of planning from the beginning.

In that vein, please note that the provided instruments need not be "set in stone." Adjustments can be made if MCPS wants to (a) add items to meet specific needs (bolstering measurement) or (b) omit administration of portions of the surveys if those survey portions are extraneous to the current evaluation goals (and thereby reduce time taken for the survey administration sessions).

Consider Demands on Teachers and Students

As noted above, there are practical concerns in administering surveys. A primary concern is time demands. For example, data gained from survey administrations is often instructional/learning time taken from the teacher and class. MCPS should therefore weigh the costs and benefits involved in how extensively to survey respondents (and make adjustments accordingly).

Another demand is on student capabilities for answering surveys independently. With proper instruction, the Student Technology Questionnaire is appropriate for third-grade (or older) students to complete in group format. As with most surveys, it is likely that first- and second-grade students will require assistance from aides or older students to provide valid data.

Consider Linkages With Other Projects

When tailoring survey use to this (or another) project, MCPS should consider other potential projects for which they might like to compare data. For example, one might wish to compare technology use across reading and mathematics programs. If so, the tailoring process should be complemented with measures that are common across projects.

Timing

There are various ways in which to time survey administrations. If one chooses to take a "snapshot" of technology use (and the relation with student learning and achievement), survey administration can be timed for the period of the year that is of interest (e.g., end of the spring semester). On the other hand, if one chooses to assess *change* in technology use (and the relation with student learning and achievement), taking a "pre-post" approach would be more appropriate than a "snapshot" approach. Pre-tests typically take place prior to implementation of the program (e.g., in spring of the prior year or the beginning of the first semester of implementation). Post-tests are typically timed in one of two ways: (a) after the program has run (or as close to the end of the spring semester as possible), which provides assessment of change from pre-test to the end of the program; or (b) at the end of the spring semester of each year that the program is implemented, which provides an ongoing record of change across the course of the program.

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The Snapshot Survey Service:
A Web Site for Assessing Teachers' and Administrators' Technology Activities, Beliefs, and Needs

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The Need for the Snapshot Survey Service: Enabling Informed Decision Making

Schools and school districts are making all manner of decisions with regard to technology (e.g., buying computers, providing teachers with professional development, installing Internet connections, and constructing curricular materials with embedded technology). All these decisions will involve teachers at some point. Thus, a rational decision-making process would include an assessment of where teachers stand on various key issues, including the following:

- What are the beliefs of teachers with respect to technology?
- What are teachers' *real* needs with respect to technology?
- How do teachers currently use technology?

Further, inasmuch as technology brings about rapid changes even in schools, an assessment of these issues needs to be carried out on a regular basis, at least every semester. A baseline needs to be established and then follow-up assessments need to be routinely conducted in order to better understand the patterns of growth and change in teachers' and administrators' activities, beliefs, and needs.

In contrast to the more traditional academic survey studies that operate on a three-year cycle, we have developed an Internet-based technology—The Snapshot Survey Service. This service enables educators at the local, state, and even national level to survey, quickly and at low-cost, other educators on issues that are particularly important to their local area.

In what follows, we document our efforts at constructing, deploying, and analyzing Snapshot Surveys in a range of educational settings—from surveying 3,100 teachers and administrators across Nebraska to surveying all 70 educators from Glendale, Pennsylvania, a small rural school district. The section headings follow the list of deliverables as set out in the initial contract.

Experiences in Carrying out the Snapshot Survey Process

During the contracting period of this effort, we hosted the following Snapshot Surveys:

- **State of Nebraska, February 11-22, 2000:** Essentially all 23,000 educators in the state of Nebraska received letters inviting them to participate in the Snapshot Survey (http://snapshotsurvey.org/nebraska). Approximately 3,100 Nebraska teachers and administrators took the survey during that period.
- **Educational Leadership Magazine, April 13-25, 2000:** We placed an announcement in the April issue of *Educational Leadership,* inviting readers to participate in a Snapshot Survey (http://snapshotsurveyorg/EL). The magazine's readership is greater than 100,000—approximately 70 individuals took the survey.
- **The school district in Glendale, Pennsylvania, June 1-15, 2000:** All 70 educators in this small school district completed the survey at http://snapshotsurvey.org/glendale.
- **Electronic Communication Across the Curriculum in K-12, July 1-14, 2000:** All 14 K-12 teachers from the central Upper Peninsula of Michigan attending a workshop at Michigan Technological University took the survey at http://snapshotsurvery.org/ecac. (This is also part of one of the Challenge Grants.)

In addition, Dr. Gerald Knezek, Professor, University of North Texas, used parts of our Snapshot Survey in his work with educators in Allen, TX. Dr. Knezek is responsible for evaluating a U.S. Department of Education Challenge Grant. As well, Dr. Eric Klopfer, Assistant Professor, MIT, used the Snapshot Survey (http://education.mit.edu/summer/survey.htm) as part of an evaluation instrument for a workshop he ran at MIT for K-12 teachers on the use of StarLogo for learning.

We have had numerous inquiries about running a Snapshot Survey in other locations. School board members, principals, and teachers have contacted us about what it would take to run a Snapshot Survey in their school district or school. We have had more than a dozen follow-up conversations, via e-mail, with different individuals after their initial inquiries. A decision to commit the time and resources (minimal as they are) to running a Snapshot Survey requires the buy-in from a broad range of individuals. Given how arduous decision making is in public schools, getting a clear go-ahead is a challenge. Getting significant follow-through is even a greater challenge. Some of our experiences have included the following:

- Mr. Bruno, director of technology in a small district in Glendale, was able to bring about a quick and favorable decision and followed through to get all his colleagues to take the survey.

- In contrast, we worked with a large district in a southern state where the superintendent made the decision relatively quickly to do the survey, but the follow-through took a backseat to other activities in the district. In the end, they did not conduct a survey because people were too busy and it seemed too low a priority.
- We have been in discussions for over a year with educators from New York about running a Snapshot Survey for all the educators in that state. While there is clear interest, actually coming to a decision has turned out to be quite complex. For example, in response to concerns from some in New York, we have prepared a Frequently Asked Questions Web page: http://snapshotsurvey.org/papers/faq.htm

The lesson is clear: from our experiences in successfully conducting the four surveys identified above, it takes someone to assume the commitment to marshal the resources, persuade the teachers and administrators, and follow through for a period of time.

Results of Snapshot Survey Process

Physics identifies universal laws (e.g., force = mass * acceleration) that apply in Idaho, Michigan, and even California. However, in the social sciences, that which is local is key. For example, the differences in location, culture, weather, commerce, and so on between Utah and Florida converge to generate differences in educational systems. In particular, "teachers" is not a homogeneous population. There are elementary school teachers and secondary school teachers; there are science teachers and language arts teachers; there are teachers new to the profession and teachers who have taught for 30 years. And, there are wide differences in teachers with respect to their comfort and expertise using technology for teaching and learning.

The Snapshot Survey, then, is a means by which a school, district, state, or even country can access teachers and administrators and discover their needs, beliefs, and uses of technology in the classroom. Moreover, it is a means to determine subgroups, the differences in the teacher population. For example, we observed that math teachers in Nebraska are markedly different from science teachers in Nebraska in their comfort and expertise in the use of technology in the classroom. And, as the number of individuals in the survey increases, we can break subgroups down even further. Based on analysis of teachers at such a fine-grained level, decisions can be made that are specifically tailored to particular subgroups.

This notion that "teachers are not a homogenous group" displays itself in our analysis in two ways. First, we argue that there are two broad audiences for findings from the Snapshot Surveys. Second, we provide an example of a fine-grained analysis by looking specifically at a few significant differences between science and math teachers in Nebraska.

Two Audiences: The Details Matter

Broadly speaking, there are two audiences for the results from a Snapshot Survey:

1. *Local Audience:* The organization that sponsors a Snapshot Survey is the primary consumer of the information gathered in the Survey. In particular, each organization individualizes a Snapshot Survey by including questions that are specific to that

organization. For example, in Table 1 we provide several questions each that Nebraska and Glendale included.

2. *National Audience:* There are a number of questions that we have used in every Snapshot Survey we have conducted; several of those questions are included for illustration in Table 1. While one needs to exercise care in comparing findings across different locales,[1] the differential findings to these sorts of questions are provocative. Of course, the local sponsoring organization will also find the data from the "standardized" questions informative.

Table 1: Locally Interesting Questions: Glendale, Pennsylvania

Please indicate you level of agreement with the following statements:	**Mean**	**Strongly Disagree**	**Disagree**	**No Opinion**	**Agree**	**Strongly Agree**
Telephone service in my classroom has been educationally useful.	3.88	5	2	11	29	22
		7.2%	2.9%	15.9%	42.0%	31.9%
Cable television in my classroom has been educationally useful.	3.09	7	7	35	15	6
		10.0%	10.0%	50.0%	21.4%	8.6%
The transition to incorporating technology into the district has been handled in a professional and effective manner.	3.39	7	3	21	35	5
		9.9%	4.2%	29.6%	49.3%	7.0%
I believe that in the coming school year I will be able to use the new technologies to benefit my students.	3.72	2	4	12	44	7
		2.9%	5.8%	17.4%	63.8%	10.1%
I would like to see locally developed educational materials (e.g., school events) distributed over the school cable network.	3.87	1	2	18	33	16
		1.4%	2.9%	25.7%	47.1%	22.9%
My students have benefited from the Compass Learning computer-based instructional system.	3.47	4	3	32	18	13
		5.7%	4.3%	45.7%	25.7%	18.6%

Table 1 is quite interesting. Ignoring the "no opinions" for a moment, one can see that the educators in Glendale were pleased with the use of different technologies (from the telephone to a computer-assisted instruction system). Indeed, there is an upbeat attitude as the Glendale educators head into the coming school year. Now, why are there so many "no opinions"? More analysis is needed. Perhaps the "no opinions" on the last question (use of the Compass Learning System) was due to the fact that those respondents didn't use the Compass Learning System and thus a "no opinion" is just that!

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[1] The Snapshot Survey typically violates the assumption of a "randomized" sample. (In Glendale, the Snapshot Survey was more of a "canvas" since all educators participated in the survey. However, in Nebraska, the 3,100 educators who provided information on the Snapshot Survey were not drawn from a random population.) Unlike the survey work of researchers such as Henry Becker, those taking the Snapshot Survey are not chosen at random. However, by aligning demographic data on the various populations, one can make comparisons. More generally, the Snapshot Survey technique, where the Internet is used to tap into a population, is serving as yet another challenge to traditional assessment methods. Statistical methods need to be invented that take advantage of the opportunities afforded by the Internet in sampling nonrandomized populations. Simply discounting these sorts of data because they violate traditional experimental guidelines is not a viable strategy; our analysis methods need to keep pace with the emerging technologies available for sampling.

However, the need to analyze the data at a deeper level—and perhaps carry out follow-up interviews with selected respondents—illuminates another problem that must be addressed: While academics might feel comfortable exploring the data, it is not clear that local school staff will be so inclined. How much gratis work can we do? Will districts pay for this sort of analysis? In the bigger districts, there might well be a statistician on staff who would have the expertise to deal with these data. However, orchestrating communication so that this person participates along with the others now becomes key.

Table 2 shows the Nebraska teachers feeling quite solid about integrating technology into the classroom. Designing Web pages is another story; but do most teachers need to design Web pages? It would be interesting to look at what these same positive teachers said about their needs, beliefs, and uses of technology. Yes, they can design lessons that use technology—but do they? Again, answering these sorts of questions requires considerable skill in analyzing data. Frankly, it is not likely that in the near term we will be automating these sorts of deeper analyses.

Table 2: Locally Interesting Questions: Nebraska

Rate your agreement with the following statements:	**Mean***
I feel comfortable with designing lessons that integrate the Internet.	2.73
I feel comfortable with authoring Web pages.	1.90
I feel comfortable with designing lessons that reflect Nebraska or district or national curriculum standards.	2.72
I feel comfortable with designing lessons that integrate more than one discipline.	2.98
I feel comfortable with designing lessons that integrate technology.	2.82

*4-point scale: Strongly Disagree, Disagree, Agree, Strongly Agree

In Table 3, we list the findings from the Glendale Snapshot Survey, where there were only 70 respondents, and the findings from the Nebraska Snapshot Survey, where were there over 3,100 respondents. As we pointed out earlier, given that these two "samples" are not randomly selected, there is some concern that drawing an inference from comparing these two sets of numbers is not statistically valid. To be statistically valid, one needs to align the samples along common demographic lines. Indeed, going to those lengths is warranted if one can conclude that there really is not much difference between the two groups with regard to these questions.

Table 3: Standardized Questions (Questions That Appear on All Snapshot Surveys)

Please indicate your level of agreement with the following statements:	**Glendale Mean**	**Nebraska Mean**
I believe that electronic media will replace textbooks within five years.	2.38	2.40
I believe that it is a waste of time for students to search the Internet, and thus, teachers should provide them with specific sites to visit for class assignments.	2.64	2.55
I believe that the role of schools will be dramatically changed because of the Internet within five years.	3.35	3.45
I believe that the role of the teacher will be dramatically changed because of the Internet within five years.	3.23	3.22
I believe that I am a better teacher with technology.	3.41	3.78
I believe that having my students search the Internet for information for a classroom assignment is time well spent.	3.40	3.67

Teachers, Science Teachers, and Math Teachers in Nebraska: Details Matter Again

The charts in this paper expand on the data analysis of the recent Nebraska Snapshot Survey presented in the accompanying report. Here are some notable findings:

- While the secondary science teachers report that they do believe that technology can lead to increased learning, and while they report having the lion's share of the classroom Internet-connected computers, they do not report using those computers any more than other teachers (except math teachers; see below).
- While the secondary math teachers use computers and the Internet for their own purposes at home and at school with the same frequency as do the non-math teachers, nonetheless, the math teachers need more compelling reasons why they should use technology in their classrooms. Acting on this belief, they use computers and the Internet significantly less frequently than teachers from other disciplines.

The legend for the following three tables is as follows: √√ means the group chose the decision significantly more often than the other group; √ means the group chose the decision significantly less often than the other group.

Table 4: Math Teachers Versus All Other Disciplines

Secondary Teachers in Nebraska	**Math Teachers**	**All Other Disciplines**
Beliefs		
I'm a better teacher with technology. (21.5)	√	√√
Electronic media will replace textbooks within the next five years. (21.1)	√	√√
Attitude		
Comfortable designing lessons that integrate the Internet (19.1)	√	√√
Comfortable designing lessons that integrate more than one discipline (19.4)	√	√√
Needs		
Need more training to use technology (12.3)	√	√√
Need more technical support to keep the computers working (12.8)	√	√√
Need more compelling reasons why I should incorporate technology into my classroom (12.10)	√√	√
Need faster access to the Internet for my students (12.11)	√	√√
Need access to faster, more powerful computers for my students (12.12)	√	√√
Computer Use		
A typical student would use a computer (but not the Internet) for curricular purposes. (16.3)	√	√√
A typical student would use the Internet for curricular purposes. (16.4)	√	√√

Table 5: Math Teachers Versus Science Teachers

Secondary Teachers in Nebraska	Math Teachers	Science Disciplines
Beliefs		
Electronic media will replace textbooks within the next five years. (21.1)	√	√√
Attitude		
I am comfortable designing lessons that integrate the Internet. (19.1)	√	√√
Needs		
Need more training to use technology (12.3)	√	√√
Need access to more computers for my students (12.5)	√	√√
Need more access to the Internet for my students (12.6)	√	√√
Need more technical support to keep the computers working (12.8)	√	√√
Need more compelling reasons why I should incorporate technology into my classroom (12.10)	√√	√
Need faster access to the Internet for my students (12.11)	√	√√
Need access to faster, more powerful computers for my students (12.12)	√	√√

Table 6: Science Teachers Versus All Other Disciplines

Secondary Teachers in Nebraska	Science Teachers	All Other Disciplines
Attitude		
I feel comfortable with designing lessons that integrate technology. (19.5)	√√	√
Needs		
Need more time to change the curriculum to better incorporate the technology (12.2)	√√	√
Need access to more computers for my students (12.5)	√√	√
Need more access to the Internet for my students (12.6)	√√	√
Computer Use		
A typical student would use a computer (but not the Internet) for curricular purposes. (16.3)	√	√√
YOU use a distance-learning classroom for a class. (16.5)	√√	√
YOU use a distance-learning classroom for meetings. (16.6)	√√	√

Impact of Snapshot Survey Process

While we had hoped to already see some impact from the findings of the Snapshot Surveys in Nebraska and Glendale, we are seeing that the results are still being digested by each of these communities:

- *Nebraska*: The report that was presented to the Nebraska State Board of Education is reprinted as Appendix A. Dr. Topp has been asked to present the findings from the survey at various state meetings; he has been asked to continue such presentations through fall 2000.
- *Glendale*: Mr. Dennis Bruno, director of technology for the Glendale school district and sponsor of the Snapshot Survey, said "The survey...has provided important information to

> guide our activities in the fall." However, little will happen until at least August when the school administrators and teachers come back from vacation.

Thus, at this point we must remain mute about how the findings from the Snapshot Survey actually impacted the sponsoring organization. Needless to say, however, we will follow up with Dr. Topp (Nebraska) and Mr. Bruno (Glendale) this fall.

Snapshot Survey and Web Site Design Rationale

In this section, we describe a range of issues that bear on the construction, administration, and analysis of the Snapshot Survey.

Choice of Questions

We have been evolving the specific questions and their wording for approximately two years. Quite frankly, we are still revising both! Our intent is to discover the beliefs and needs of teachers when the teachers are broken down into different groupings. As well, we want to correlate those beliefs and needs with the actual uses of the technology by the teachers themselves at home and at school and by their students. Beliefs impact actions; if teachers are not convinced of the value of the Internet, it is not surprising that they do not use the Internet with their students.

We are settling on approximately 10 demographic questions and 20 beliefs, needs, and use questions. There are different questions for administrators. Using a version of "adaptive testing," we can dynamically alter the survey based on the answers provided by the respondents.

Interface Design

We have now had upwards of 3,000 educators fill out the Snapshot Survey. Overall, the Survey has proven itself to be quite usable. We had a few reports from respondents who said they had to scroll horizontally to see the whole survey. We were not able to track down this problem, though we surmised it was a browser-specific issue. Thus, we feel we have developed a format that is accessible and useable.

Collecting Data: Human Side

In Nebraska and Glendale, we sent out letters to educator who then distributed them to teachers and administrators at their schools. We also involved local school personnel to encourage their colleagues to fill out the Snapshot Survey. In both Nebraska and Glendale, some time during inservice events was devoted to teachers and administrators going online to fill out the survey. Thus, we feel we gave the vast majority of potential respondents ample opportunity to know about the Snapshot Survey.

It is a reasonable conjecture, however, that only those educators in Nebraska who felt comfortable with the technology and had access to it responded. This group of respondents was likely more technology-savvy than those who did not respond. We are trying to gather demographic data on these issues now.

In contrast, in Glendale, all the educators responded to the Snapshot Survey. Clearly pressure was brought to bear on them; otherwise the turnout would not have been so complete.

Interestingly, the Glendale Snapshot Survey required respondents to enter their names. However, in the Nebraska Snapshot Survey, it asked for e-mail addresses and stated quite clearly that this was voluntary information and would be kept private. We still intend to send those that gave us their e-mail addresses information on how their answers related to those of the group.

Collecting Data: Technology Side

We employed three Windows NT servers to support the Nebraska Snapshot Survey. An Oracle database underlies the Snapshot Survey. Only two servers were used for the Glendale Snapshot Survey, however. While we kept a constant eye on the data coming in, we feel we need to increase the automatic checks of data integrity. Moreover, we are planning on moving to a Sun Solaris environment; given the limited resources we have, it is difficult to keep the NT servers up and running.

Analysis and Display of Findings

In this early stage of our efforts, we are still evaluating the analyses by hand using SPSS. For example, a baseline analysis of the Glendale Snapshot Survey data is displayed at: http://snapshotsurvey.org/glendale/results.html. As we note below, however, we need to incorporate more automation if we are ever to make this service a rapid, Internet-time service.

We have made little progress on our goal of providing individual respondents with individualized feedback. We did not, as we had outlined in our original proposal, provide users with a Web page with information about their responses in comparison to responses of others in the sample. Rather, we focused our attention on supporting more Snapshot Surveys and on rebuilding the "plumbing." However, we have a moral obligation to provide respondents with this information and we will still do so.

Automation Issues

In order to truly make the Snapshot Survey an Internet-type service where school organizations can come and create a survey with almost no intervention on our part, we need to increase the amount of automation available. There are, in fact, Web sites that users can access, create surveys, and have them administered for a fee, of course. We feel that we have a solid framework upon which to build those automated services: The survey is totally database generated (Oracle). From the database, we can create a survey and a baseline display of the findings, e.g., http://snapshotsurvey.org/glendale/results.html.

Presentations

In addition to the Web site at http://snapshotsurvey.org, we have produced the following:

- Press Conference, February 25, 2000, Indian Falls, Nebraska, hosted by the Secretary of Education of Nebraska
- Demonstration (Invited), March 7, 2000, Washington, DC, The John Glenn Commission on K-12 Math and Science Education

- Keynote (Invited), May 1, 2000, New York City, New York, SchoolTech Conference
- Keynote (Invited), May 12, 2000, Kansas City, KS, eSchool News Workshop on Grants and Funding in Education
- Spotlight Session (Invited), June 24, 2000, National Educational Computing Conference (NECC), Atlanta, Georgia

Concluding Remarks

The NCREL seed funding has enabled us to build an initial Web site to support the Snapshot Survey Service. We have carried out several Snapshot Surveys and had a shakedown of our basic procedure. We have achieved all the goals initially set out in our proposal save one—we have not yet provided feedback to individual respondents.

However, in the next incarnation, we plan to take an even bolder step: In addition to providing a Web page that contains information about a respondent's answers and their relation to the sample's answers, we plan on providing information tailored to the specific needs of the respondent. For example, if the respondent notes on the Snapshot Survey that he/she needs more training with technology, we will create a Web page that contains information about workshops and mini-courses in that person's local area. As well, we will recommend Web sites, books, and magazines depending on the respondent's subject area and grade-level assignment. The information on the local courses is available, typically, from the regional education/technology organization. We are planning on rolling this service out in the fall in our Snapshot Survey in New York. We are also planning on carrying out surveys in Texas.

The Snapshot Survey Service is an example of the emerging new generation of technologies that can provide new and novel support for learning and teaching. We greatly appreciate the funding from NCREL; it has gotten us off to a great start!

Appendix A:

A Snapshot of the Implementation of Education-Related Technology in Nebraska's K-12 Schools

Executive Summary of Preliminary Findings

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Introduction[2]

Nebraska educators are moving to integrate computer and Internet technology into the curriculum in schools and classrooms around the state. In order to get a picture of how this implementation is progressing, we invited the approximately 23,000 educators to log onto the Internet and take the Nebraska Educational Technology Snapshot Survey. In the 10 days of this Internet-based event, 14 percent of Nebraska teachers and administrators volunteered responses to the survey.

The snapshot provided by these data is clear; Nebraska is making definite progress toward having K-12 schoolchildren use computers and the Internet.

- Thirty-nine percent of the educators reported that their students use computers for curricular activities for at least one hour per week, and an additional 40 percent reported that their students use computers about 30 minutes per week.
- In 1996, a statewide survey found that 40 percent of the teachers used the Internet with their students, while the current survey found that 90 percent of the teachers are using the Internet.

But, it is also clear that educators feel that lack of access to technology is still a major stumbling block. While Internet links are available in the classrooms, more computers are needed. And, while teachers are comfortable with operating the technology, they now indicate they need time to focus on integrating the technology into the curricula.

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[2] The Nebraska Educational Technology Snapshot Survey was a collaborative effort conducted by the Office of Internet Studies at the University of Nebraska at Omaha, the Texas Center for Educational Technology at the University of North Texas, and the Center for Highly Interactive Computing in Education at the University of Michigan. It was sponsored in part by the Nebraska Department of Education, the Nebraska Educational Service Units, and the North Central Regional Educational Laboratory.

In what follows, we first describe how the Snapshot Survey was conducted, and then we present additional findings from the survey.

The Snapshot Survey Process

This Snapshot Survey of Nebraska was a cooperative venture, including the Office of Internet Studies at the University of Nebraska at Omaha, the Texas Center for Educational Technology at the University of North Texas, and the Center for Highly Interactive Computing in Education at the University of Michigan. It was sponsored in part by the Nebraska Department of Education and the Nebraska Educational Service Units. This project was designed to survey educators during a 10-day period (February 11-20, 2000) and report on the data within a few days. This short timeframe is important because of the rapid changes in technology.

In order to encourage the educators of the state to complete the survey, the educational service unit sent e-mails, posted Web page notices, and made announcements in newsletters. In addition, paper flyers were distributed to all schools to be placed in each teacher's school mailbox.

Over 3,100 Nebraska educators completed the survey, including approximately 2,350 teachers, 250 administrators, and 500 school support staff. Responding educators were from all parts of the state, all school sizes, and all grade levels.

Educators Beliefs about Technology in Education

Nebraska educators clearly see that technology is playing a key role in teaching and learning. Fully two-thirds of the teachers who responded to the Snapshot Survey indicated they believe that (1) using technology in the classroom will make them better teachers and (2) they have the skills, as defined by the Nebraska Educator Competencies in Technology, to integrate technology into their classroom lessons.

Furthermore, 96 percent of teachers feel that their students benefit from using technology. High percentages of teachers also believe that technology enables their students to produce artifacts that reflect higher-order thinking, increases their motivation, supports student collaboration, and helps students become more responsible for their learning. Moreover, teachers feel that having their students search the Internet is a useful learning activity. As one fifth-grade teacher stated, "We have researched polyhedron, mathematicians, binomial theorem, Pascal's triangle, Rational Zeros Theorem, and much more. I especially like to use it for topics that are not adequately covered in the text." Interestingly, teachers do *not* seem concerned with students coming upon inappropriate material on the Internet, but they are very concerned about the ease with which the Internet can enable plagiarism.

Most importantly, teachers spoke with a unanimous voice on one issue; they believe that parents support their efforts in working to integrate technology into the classroom. Essentially all teachers reported that they believe their school principals also support them in that effort.

Use of Technology in the Classroom

Acting on their beliefs about the value of technology for education, 39 percent of the teachers reported that their students use computers (but not the Internet) one hour or more a week, while an additional 40 percent reported their students use computers about 30 minutes per week. Internet usage is distinctly lower; 17 percent of the teachers reported having their students use the Internet for one hour or more a week, while 40 percent reported having their students use the Internet about 30 minutes a week. Teachers were willing to share their educational tactics and strategies as they provided 1,187 Internet-infused lesson ideas.

Access to Technology for Curricular Uses

Almost all teacher-respondents (89%) indicated that they have convenient access to an Internet-connected computer for their use at school. Over one-third of the teachers report that Internet Web sites are their most frequently used resource for information about teaching with technology.

The current trend in the U.S. is to put Internet-connected computers into classrooms as opposed to creating computer labs. This more flexible arrangement enables teachers to better orchestrate students' use of the technology.

- In Nebraska, 89 percent of the teachers reported that they have at least one Internet-connected computer in their classroom; of that group, only 15 percent have five or more. In fact, 11 percent reported having no Internet-connected computer in their classroom.
- Over 70 percent of the teachers indicated that they have access to an Internet-connected computer lab for their classes at least once a week.

What Needs Remain

Given the above, it is not surprising that teachers indicated that their most urgent need is more access to more computers for their students. Access to the Internet is not specifically an issue since their rooms are wired; what they need, then, are more computers to hook into the Internet. Teachers' training needs are no longer focused on just operating the technology, but rather, they need more time to fully integrate technology into their curricula and more opportunities to interact with their colleagues around the use of educational technology.

Concluding Remarks

Nebraska educators have indeed made progress toward integrating technology into the classroom. Their needs, as reported on the Snapshot Survey, indicate they are among the more technologically sophisticated users of educational technology. That is, we have found from previous Snapshot Surveys administered around the country, that as teachers become more technologically sophisticated with respect to using educational technology, their needs change. While they initially request more training in the operation of the technology, they progress to requesting more time to work the technology into the curriculum. Based on these findings, then, we might venture a prediction: As the state moves aggressively toward resolving the lack of sufficient access to technology, Nebraska's educators are poised to help their school children reap the benefits to learning that technology can provide.

Measuring Our Progress with Real Tools: Why does technology work in some schools and not in others?

Presentation outline by Bernajean Porter porterbj@edtechplanners.com

Technology as a System Lever

- Technology magnifies and makes visible all that works in a school and all that needs to work better. Porter, 1994

Over the years . . .

- Training and Conducting audits in over 2500 schools
  - Clark County Schools - Las Vegas, NV
  - Denver Public Schools - Colorado
  - DoDDs - Hanau Model Schools - Germany
  - Pinella County Schools - Florida
  - San Luis Obispo County Schools

Scalability: Illinois NextSteps: Organizing Technology for Student Results

- Sponsored by NCRTEC/NCREL with ISBE
- State-wide toolkit for assessing technology's impact
- Six-day Internship Training
- Training 150+ educators to conduct technology and learning audits
- Seven regional states shadowing project

Asking BIG Questions of Our Technology Investments

- What's happening for ALL students?
- What is the "added-value?"
- What's worth the dollars, energy and effort?
- What learning that we value would be impaired or impossible without the technology?

Making IT Happen for ALL Students

- Schools need a force-field analysis of what's working and what needs to work better **in the system** to address the technology issues of scalability, equity and accountability.
- Cannot move past initial 20-30% of the system adopting the innovation **without** the system making a concerted effort to adapt its culture and norms to enable the benefits bringing added-value.

Stages of Staff Development – Guskey, "The Age of Our Accountability" JSD, Fall 1998

- Note: Unless the system makes a concerted effort to address the issues occurring at Stage III, the gains in Stage I and II will dissipate over time.
- Stage I: Attitudes
- Stage II: Knowledge, skills and new attitudes
- Stage III: Organizational support and change
- Stage IV: Use of new knowledge and skills
- Stage V: Student learning outcomes

Diffusion of Innovations - Rogers

- 8% Trailblazers (innovators)
- 17% Pioneers (early adopters)
- 29% Settlers (early leaders)
- 29% Stay-At-Homers (late leaders)
- 17% Saboteurs (naysayers/resisters)

Systems Alert! Assessing Pervasiveness!

- Systems tolerate 25 -30% novelty - then the system tries to kill IT off!
- When the percentages begin to reach at least 50% - You have early signs that the system is beginning to support, adapt and change itself in order to incorporate the benefits of the innovation. Lots of work ahead for collaborative leadership strategizing barriers!
- When the percentages reach 80% or better - you have now established new norms in the organization

First Order Change

- Focused on technical tasks
- Focused on getting people to do IT
- Focused on efforts
- Focused on broad, generalized learning goals

Second Order of Change

- Focused on re-culturing
- Focused on addressing equity / building critical mass
- Focused on meaningful, "worth-the- money" student uses
- Focused on added-value results
- Focused on specific, measurable learning goals

Organizing the System for Student Results

Next Stop: Systems Thinking

- Issues: Scalability, equity, and accountability
- Implementation teams need to be "Cat Herders"
- Organizing for Return On Investment (ROI)
- Preparing for Second Order of Change

ETP's Four CornerStones

Each of the four questions have 6 Indicators. All four areas need equal attention to address technology's issues of scalability, equity and accountability. There are over 75+ templates and tools organized to measure all indicators. Sample reports are organized into four chapters representing each of the four areas. See pdf file ETP's Four Cornerstones.

I. Readiness to Change
II. Teaching and Learning
III. System Capacity
IV. Technology Deployment

Data Collecting is a BIG Job!

- Identifying what you need to know
- Ranking guide for each indicator
  - Qualities / Traits
  - Assessment tools for each indicator
  - Triangulation - three or more data sources to create a "thread of truth" that districts can trust enough to take action on!
- Processes are needed to operationalize the frameworks into doable, usable tasks that provide practical information to school teams

Example: Indicator 2: Leadership measures six traits in order to draw conclusions

- Stewardship
- Collegial strategizing
- Change management
- Support/expectations of staff
- Professional skills/practices
- Urgency

Data in their Face – Going for "Catalytic Validity"

- Educating and mobilizing the system
- The degree to which the research (information) energizes participants toward knowing reality in order to transform it."

Studying Your Own School,
1994 Gary Anderson et al.

District Strategy Retreat – This process is critical to involve groups in owning the problems and the solutions

- Member's Check – provides a quality gate in reviewing the data
- Creating Action Plans from the data reports

Where's the Flashlight?

- Efforts vs Results – Michael Schmoker's book, *Results*
- Equipment efforts vs instructional results
- Automating or re-culturing our schools as we know them today

Tech Plan Analysis Tool – (see pdf file)

- Section 1: Overall Technology Plan
- Section 2: Analysis of Goals of Efforts or Results
- Section 3: Analysis of Successfully Organizing Goals for Student Results

In the Beginning . . .

- Technology plans = purchase orders
- 3-5 years ago "learning" became expected as part of federal / state funding
- Problem --- technology committees worked separately from curriculum groups
- Many groups solved this dilemma with broad "fluff" words to keep from invading teacher / curriculum domains

Glorious Goals Found in State and District Plans – How do you measure these?

- Enriching
- Enhancing
- Supporting standards
- Creating life-long learners
- Raising student achievement
- Integrating – how is it being defined?

Integrating is . . .

- Do something
- Do anything . . .
- Just use it!

Translated as . . .

- Do what you can
- Do what you want

- As long as you use it . . .for something!

Sample Goals – try categorizing these for assessment instruments

- Students will be life-long learners in a technological society.
- Technology will be integrated throughout the curriculum.
- Technology will enrich/enhance student achievement
- Teacher, principals, and students will have opportunities to become comfortable with technology to improve all aspects of learning.

ETP's Spectrum of Technology and Learning Uses

- Literacy Uses – telling technology stories about student learning
- Adapting Uses –telling the same stories about student learning with new tools
- Transforming Uses –telling new stories NOT possible or probable without the technology

Mapping Learning Uses

Item analysis of staff development workshop titles, teacher lesson plans, interviews and technology plans into the three categories of technology and learning uses. Generally what is being taught to the teachers is what is actually being implemented in the classrooms. Are you teaching what you want to happen in the classrooms for students?

The question is not what category you are supporting with technology uses – the real question is are you getting what you want? Is what you are getting worth the money and effort?

What ETP is Learning. . . Schools are NOT Presently Organized for Results

- Scoring "Accountability Readiness" – see www.edtechplanners.com for on-line scoring of essential elements needed to organize for accountability.
- What we have found in hundreds of schools conducting audits:
  - Schools are not presently organized for student results
  - Critical mass of systems are in first order of change
  - Technology use is optional NOT essential
  - Goals are focused on "efforts" rather than student RESULTS or benefits
  - Goals/indicators are NOT presently measurable
  - Baseline data for student results has NOT BEEN collected to chart progress
  - Data collection is mostly about technical availability and use
  - Learning evidence is presently more anecdotal than empirical
  - Funds ARE NOT allocated for data-based decisions / evaluation

ETP has recently partnered with Phi Delta Kappa to train educators through six-day internships to acquire the skills and tools to assess and evaluation their technology's impact. (See www.pdkintl.org for details.)

Skills do NOT Equal Practices

Surveys alone cannot reveal what is really happening for students. Surveys are one-dimensional reportings. Sometimes they tend to represent "collective delusions" of what is happening. Need external evaluators to conduct observations, interviews, and focus groups in connection with surveys to determine what's working and what needs to work better with actual practices.

First/Second Order Evaluation

- First Order -- Efforts
  - Measuring the doing
  - What happened for adults and equipment?
  - What was completed/accomplished?
- Second Order -- Results
  - Measuring the growth of benefits / changes
  - What happened for students?
  - What is the "added-value" NOT possible before the investment of dollars and the implementation work?

How Does IT Really for Students?

Classroom Observations: "Knowing the Culture Context"

Walk-through Observations in Buildings – Help assess the following indicators:

- Ubiquitous Access
- Equitable Learning
- Tool Capacity
- Connectivity

- Pedagogical Readiness
- Instructional Practices
- Student Work

Interviews: The Real Story

- Leaders
- Teachers
- Parents
- Community
- Students

NEW! Evaluating Student Products

NCRTEC/NCREL in partnership w/ Education Tech Planners

- How about using student products to deepen the evaluation of the impact of technology on student learning?
- 70+ Comprehensive Assessment Tools
  - To determine the quality of content/craftsmanship of student work
  - To conduct a meta-analysis of the system use of technology

Collaborative Development

- Sponsored a national think-tank team
  - Annette Lamb
  - Lisa Holms
  - Anita Dosaj
  - Bernajean Porter
  - Kristin Ciesemier
  - Marilyn Jerde
  - Bruce McKay
  - Ian Jukes
- Critical friends
  - Karen Bunting
  - Lynell Burmark
  - Jim Sydow
  - Tom Valentin
  - Carolyn McCullen
  - Helen Hoffman
  - Pete Denzin

Student Products Help Assess the System's Use of Technology (see pdf file SystemAssess/Student Products)

- What are the expectations and results of student computer-based products?
- Nine indicators score the system:
  - Standards-based Learning
  - Curriculum Linking
  - Cognitive Tasks
  - Assessment Practices
  - Content Achievement
  - Craftsmanship of Communication
  - Authentic Tasks
  - Instructional Uses / Practices
  - Added-value

Eight Trait Student Product Scoring Guides (see pdf file "Overview of Scoring Guides" and "Sample Scoring Guide")

- ➢ Part I: Content Communication
  - ➢ Preparation of Tasks
  - ➢ Content Knowledge
  - ➢ Format/Organization

Craftsmanship of Tool Use

- ➢ Part II: Pathways of Communication
  - ➢ Text Communication
  - ➢ Image Communication
  - ➢ Voice / Sound Communication
  - ➢ Design of Communication
  - ➢ Interactivity of Communication

Five Uses of the Tools

- ➢ 1. External evaluators *
- ➢ 2. Internal evaluators *
- ➢ 3. Staff training *
- ➢ 4. Peer collaborative scoring *
- ➢ 5. Individual scoring
- ➢ ***Collaborative assessment used in 1-4 Uses**

Classroom "Running Records"

- ➢ Using Student Product Evaluation Tools for
  - ➢ Continuous assessment of student work
  - ➢ Capacity to assess progress over time

Grappling with Accountability: Resource Tools for Organizing and Assessing Technology for Student Results by Bernajean Porter

- ➢ Field-tested 8 years
- ➢ Do-it-yourself guide
- ➢ ETP's Four CornerStones Framework plus
- ➢ 80+ digital tools / templates / sample reports
- ➢ Processes for data collection, project management, as well as for energizing and mobilizing the system to take action

Ready or NOT!

Herding those "CATS"

- ➢ It's not going to be enough to know how to do IT . . .
- ➢ we are going to have to be able to do IT even when we don't know how!

For More Information:

- www.edtechplanners.com -- To download conference handouts, use all caps and the following key words – User ID = DOE Password = KIDS
- www.pdkintl.org – To request more information on workshops, on-line survey services, and comprehensive technology audits.

Renaissance 2000

An impact paper by:

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Winter, 2000

The view from the edge...

The edge of the millennium makes a good vantage point for thinking about the future in terms of the past. Like standing on a mountain ridge where the view is unobscured in all directions, it is exciting to be poised on the cusp of time with the opportunity to take the long view. Of course, in the case where time is our horizon, the view is less than clear. Even so, when viewed in terms of epochs instead of years, broad patterns emerge that might lie hidden when we focus on the short term perspective encouraged by the incredibly fast pace of life that has been the focus of the past few years.

From this historical perspective, I am convinced we are at the dawn of a new renaissance -- Renaissance 2000, or R2K -- a renaissance that, like the first one, will have a tremendous impact on all aspects of our lives from education to

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business. As with the earlier renaissance, this one will be triggered by a communications revolution. Unlike the previous renaissance, this one will reach hundreds of millions of people scattered throughout the far reaches of the globe.

That was then...

A little over 500 years ago, the European explorer Columbus "discovered" the New World. We attribute the discovery of the Americas to Columbus, even though we now have evidence that Viking explorers had found our continent about 500 years before. So why do we celebrate Columbus and not the earlier explorers? Why didn't the Vikings trigger an age of exploration and discovery? These questions have complex answers, but one factor that might be of great relevance is that, in the period between the two series of discoveries, the moveable-type press became available in Europe. The printing press allowed books and tracts to be mass produced at low cost for the first time in history. This meant that news of the explorers' journeys could be spread quickly over large distances, triggering excitement in those who could find ways to prosper with this information, or whose creativity was triggered by the discovery of lands to the West. In the absence of the press, news of the Nordic exploits were hidden, and the capacity of these discoveries to trigger creativity in the population of Europe were limited. As Paul Levinson points out in his book *The Soft Edge*:

> Socially, technologically, scientifically, the Europe of 1000 AD was in no condition to embark upon an epoch of discovery and settlement across the Atlantic. But part of the reason also lies in the way that word of the Norse discoveries must have reached people back in Europe, if it reached them at all. Couched in oral sagas, whispered in the cold winds, the words had no endurance. (p26)

There is little question that within the first fifty years of Gutenberg's first Bible, the press was starting to have a major impact on the flow of information. In 1493, for example, an eight-page pamphlet describing Columbus' exploits became a best seller, with editions appearing in Rome, Paris, Basel, Antwerp, Florence, Germany and Spain. The appearance of this document in several languages helped its popularity. The concreteness of the printed form gave substance to its words, and nations reacted. England sent Cabot to the new world in 1497, and the Portuguese funded Cabral's discovery of Brazil in 1500.

This impact of a medium of communication on the creation of an age is reflected in the thoughts of Levinson and others: "Read All About It! The

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Press Discovers America!"

In fact, the informational technology of the printing press was still at an early stage when Columbus made his journey. But with the publication of the complete works of Virgil in Italian by Aldus Manutius in 1501, the stage for an explosion in information was well set. The appearance of the classics in inexpensive bound volumes triggered the creativity of an age. It is as though the rise in access to information led directly to a rise in creativity. While it is true that the Renaissance had its share of brilliant thinkers, there is little reason to doubt that equally brilliant minds could be found at any period in history. It was the capacity to bring audiences to these minds that made their contributions noteworthy. When we think of the Italian masters, for example, names like Leonardo, Michelangelo, Rafael and others dominate our thinking. But without the communications climate that supported the creativity of these (and numerous other) masters, their work might well have been hidden from view. The flowering of science and art that we associate with the Renaissance was as much a product of the new medium of communication as of anything else.

This is now...

So what does this imply for us at the dawn of R2K? As with the first Renaissance, this one is triggered by a new mode of communication -- one as powerful as print, and one with powers that print never had: the internet (and, in particular, the World Wide Web).

The era just ending has gone by several names: the Information Age, and the Communication Age, to name just two. (One term that captures the essence of our current use of technology is "telematics," a word used outside the United States to describe the combined effect of computing with telecommunications.) The focus during this period was on the growth of access to information through electronic media that, unlike radio and television, were under the control of the user, not the broadcaster. Even the vaunted power of the press pales in comparison with the capabilities of this new medium. Media of the past were purely informational. The Web is both informational and interactive. Furthermore, virtually anyone with the tools needed to access the Web can also become an author. The barrier to publishing has been eradicated with this new medium, giving rise to the voice of millions of authors, artists, musicians, scientists, poets and philosophers who can now share their insights with a potentially vast audience. The democratization of publishing has tempered the need for

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patrons. While the artists and scientists of the Renaissance needed (or at least appreciated) the financial support of well-heeled patrons, the barrier to communication of creative ideas has been reduced significantly.

While it is true that the Web has yet to reach into every home, it is the fastest growing communications technology in history, reaching 50 million users in only four years. Even by the height of the Renaissance, books (and literacy) had yet to reach the kind of penetration and scope the Web achieved in a fraction of the time. And, unlike printing in the 1500's, today's communication revolution is a truly global phenomenon.

From push to pull...

Prior to the Web, most informational media operated by "pushing" their content at the user. Newspapers yelled their top stories through bold headlines. Radio and television were under the total control of the broadcasters who determined how, what, and when information was to be delivered. The highly edited nature of these media had good and bad points. On the plus side, the average citizen was freed from the task of deciding what information was relevant to know. Information flow was top-down, and we trusted experts to keep us informed. The downside of this equation is that news stories that failed to capture the excitement of an editor went unreported, even if there was an audience for whom these stories were relevant.

Today users of the Web have access to information in myriad forms -- both edited, and unedited. Those who want a perspective vetted by the New York Times are free to get their news online from that source. Those who wish to read the raw wire feeds have this capability, and those interested in first-person accounts of incidents can find these unedited nuggets on-line as well.

Because the Web deals with bits instead of atoms, the physical cost of printing is removed as a barrier to reaching a wide audience. But more than that, the Web differs from earlier informational media in that it allows the users to "pull" the information from disparate sources, rather than having the information "pushed" to them by a traditional information provider.

The shift from push to pull is tremendously significant. It shifts some burdens from publishers to readers. If you are going to actively seek out information of interest, you need a different set of skills than those associated

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with a world in which information is pushed. In particular, you need to know how to locate information, how to determine if what you have located is relevant, and how to determine if it is accurate. These foundational skills were less important in a world where information was edited and pushed to users.

From atoms to bits...

Intellectual property in R2K can be made available for little cost through postings on the internet. While the creative works of the Renaissance were frozen in physical form (paintings, sculptures, buildings, books), much of today's creative offerings exist purely in the world of diaphanous bits. By separating the bits from the atoms, a dual economic structure results. The economy of atoms -- of physical goods -- is marked by the law of diminishing returns, while that of bits is marked by the law of increasing returns.

Understanding this principle affords companies the chance to split their bit-based and atom-based operations into separate divisions, or at least to understand that these two aspects of a company need to be treated differently. One good example of this can be found with American Airlines (more accurately, its parent company AMR Corp.) In 1996 AMR sold 18% of its computer reservations system (SABRE) to the public, holding on to the rest. This provided a tangible value to an informational asset. Interestingly, the remaining 82% of SABRE accounts for roughly 50% of AMR's value. In other words, one of the largest airlines in the world, with 700 jets, 100,000 employees, and exclusive landing rights in some of the world's most popular airports is worth about the same as its computer reservation system. The value of the computer system is that it can be leveraged in a way tangible assets can not. A single plane can only be used on one route at a time, but the reservation system can be used by millions of people simultaneously. The physical assets are "rival" assets -- they can only be used for one purpose at a time. Knowledge assets aren't rivals. In fact, the more they are used, the larger the return. The larger the network of users, the greater the benefit to everyone. This aspect of increasing returns leads to lock-in in the marketplace, giving tremendous power to those who establish leadership first.

With zero incremental cost of manufacturing, bit-based products can practically be given away, especially in the early phases of product development. This insures rapid market penetration and the building of name recognition that can sustain a company once it becomes well

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established. This was the approach taken by Netscape when Navigator was first released. By giving away their Web client, Netscape not only rapidly built a large user base, it forced Microsoft to give its client away in order to build a niche for itself in the same market. Without price as a competitive factor, product features become a driving force for product selection. The result was a typical example of a "Red Queen," (from Lewis Carroll's character who had to run as fast as possible just to stand still.) The competition between Netscape and Microsoft was so intense that lesser-known browser manufacturers largely fell by the wayside, leaving the market to these two companies.

All of this suggests that a key for survival in R2K is "get big fast," and there is merit in this admonition. In the absence of venture capital, though, this advice is hard to follow. This means that businesses wishing to thrive in the new millennium may need to find other strategies for success.

From commodities to experiences...

In the midst of the longest sustained economic boom in U. S. history, the downward pressure on the prices of most high-tech goods is phenomenal. Part of this can be attributed to the continued impact of Moore's Law as the complexity of silicon-based devices doubles every 18 months with a concomitant drop in cost. Most computer users are aware that the $1,500 machine on their desks outperforms multi-million dollar mainframes made a decade or so ago. But, beyond the inexorable force of Moore's Law lies another force that is bringing added pressure for lower prices. Computers have become commodities. Customers increasingly see computers as largely interchangeable boxes, any one of which will meet their needs for word processing, internet access, etc. Furthermore, customers realize that their investment will be obsolete with a year or two, and are increasingly reluctant to invest heavily in something that will be eclipsed by better technology (at the same or lower cost) in a short time.

This downward pressure on price is driven by the large number of new users who are purchasing computers for the first time. Attracted by low prices, these customers are being enticed to invest in technology. Even if their investment fails to live up to the hype, the cost is sufficiently low that large numbers of people are getting "wired," just in case. All of this is great if you are a customer. For well under $1,000, you can purchase a computer whose power would have been unimaginable at any price a few decades ago. But if you are a computer manufacturer, the picture is not so rosy. Computers obey

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the economic laws of atoms, not bits. Diminishing returns apply, and the downward price pressure of commoditization is driving much of the profit out of many companies.

Fortunately there is a solution to this problem. If you think about commodities, goods, and services, there is typically a profit premium that can be added as you move up the chain. Unfortunately, (as we've seen with computers) goods are being turned into commodities, and the same pressure will be applied to many services as well. Fortunately, as Joseph Pine and James Gilmore have pointed out in their book, *The Experience Economy*, there is another category to add to our list that resists commoditization: *experiences*. Experiences are at the top of the profit chain because they address the personalized human dimension of a product offering and because they make the customer feel special.

While the experience economy can be seen as an extension of the service economy, the underlying ideas can be applied to the goods sector as well. As mentioned above, the computer industry has experienced tremendous downward price pressure as computers are increasingly being perceived as commodities. The problem this presents for manufacturers is that the profits are being driven out of their companies. An alternative approach has been taken by several companies who have used industrial design and marketing as a strategy for turning computers into experiences. Compaq, for example, has chosen to play in several markets simultaneously. In addition to their line of inexpensive "beige box" computers, Compaq has introduced their Presario 3500 series of desktop computers that are stunning in appearance. First and foremost, these computers are state of the art in technical performance. But, beyond that, they are attractive to look at. The Compaq M300 notebook computer looks strikingly different from traditional laptop computers, and purchasers of these computers are buying into a different experience as computer users. Through their preference for elegant designs, they are communicating their interest in being apart from the pack.

Apple has based its recovery on the idea that its customers "think different." This ad campaign coupled with new Macintosh computers packaged in brightly colored cabinets has raised the interest in and profits of this company. The Palm V personal digital assistant introduced by 3Com has an industrial design that is extremely sensual yet highly functional. The ad campaign for this device implies that users of the Palm V will have a different experience than those using other PDA's (including other models made by Palm).

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Numerous other examples can be found of high-tech devices that have avoided the trend toward commoditization by providing customers with experiences -- experiences for which customers will gladly pay.

The creativity of R2K will become evident in the ways that companies of all kinds shift themselves into the experience economy. Sometimes, it will be a matter of industrial design that captures that market's imagination (and money), and other times it will be the creation of a whole new category of product or service that will drive sales. No matter which approach is taken, creativity takes a front seat in the new economy. "Me too" products will find their way to market, but the public has already made it clear that these products need to be priced very low to capture any sales. This represents a bifurcation point in the R2K marketplace. Low priced generic products will reflect the continued pressure toward commoditization on the one hand, while higher margin products that afford astounding user experiences will experience growth as well. Elegance, functionality, and quality will have a growing place in the economy, and the creative outpouring of R2K will contribute to this movement. Companies that make the shift to the experience economy will maintain high margins and do well. Those that take a back seat and compete on price will find their margins evaporating. Current size and past sales history will be of little comfort to those who fail to grasp the essential elements of the new economy.

From desktops to personal information appliances...

The personal computer has grown in popularity to become the dominant appliance of the past two decades. Computer penetration into homes has grown exponentially to reach the point where most homes in the United States have a desktop computer in them, and many of these machines are connected to the internet. Many have written about the personal computer "revolution" and its impact on business, entertainment and education. At the dawn of R2K, it is important to acknowledge what the desktop computer accomplished, as well as what it has failed to do.

First, let's look at the accomplishments. Prior to the late 1970's, computers were large devices found in special rooms in corporations, banks, and government agencies. They were seen as massive "electronic brains" that were poised to influence virtually every aspect of our lives. They were perceived as being outside the understanding of most people, and their role was often categorized as that of an emotionless dictator whose errors caused untold human grief. Even programmers and mainframe computer users saw

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themselves as being in the service of these machines. The 80-column punched card was the one link most people had with the otherwise invisible machines. The admonition to not "fold, spindle, or mutilate," was found on punched cards, and also on the t-shirts of those who felt they were in danger of enslavement by these machines.

While personal computer kits had been on the market for a few years, the release of the Commodore PET, Apple II, and Radio Shack TRS-80 in the late 1970's triggered the start of a mass market for personal computers. These (comparatively) small devices started showing up in the homes of hobbyists and other technology enthusiasts who, initially, had to create most of their own programs using BASIC. While Visicalc catapulted the Apple II into businesses, most corporations relied on mainframe or mini-computers for their data processing needs. The personal computer was seen as a problem for businesses since it decentralized computing and made life hard for system administrators. The fight against personal computers in corporations continued even after IBM belatedly entered the market with their own PC. In time, the advantage of having a computer on your desk started to outweigh the advantage of a large centralized computer under the control of a priesthood of systems analysts, and sales of personal computers in corporate settings mushroomed.

As desktop computers grew in popularity, computers became demystified. Rather than being seen as faceless dictators, computers were now seen as tools for empowerment. Given the popularity of computers today, it is hard to believe that many once feared these machines.

The main problem with desktop computers is that we call them "personal computers," when they are about as personal as a brick. While we no longer have to go to a special room to use them, we still need to be where the computer is, rather than have the computer with us. There are two reasons for this: First, the physical size and weight of these devices argues against portability. Second, they are tied to our desks with two cords -- one for power, and one for networking. For this reason, today's desktop computers are personal in name only.

But just as the desktop (largely) replaced the mainframe, the rise of truly portable information appliances will replace today's desktop computers for many users. And, just as power flowed to the user with the move from the mainframe to the desktop, so this flow will continue as the true personal computer comes into existence. Today's laptop computers represent a

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transitional technology on a continuum that includes a variety of devices ranging from Web cell phones to PDA's such as the Compaq Aero or Palm Pilot.

The personal computers of R2K will have two characteristics: battery operation, and wireless networking. Freed from the physical constraints of weight, and power and communication wiring, these devices will be with us whenever we want them, and will provide virtually anywhere/anytime access to the infosphere. These devices will probably not attempt to serve as tools for every conceivable need, but will be highly customized in function. We might carry multiple devices with us, each tailored to a specific need, and each capable of sharing information with our other devices, as well as with any desktop computers we still might be using. At least initially, these portable devices largely will be devoted to access and presentation of information, with desktop systems still being used some for authoring and the creation of new work.

Another way of thinking about this shift to personal information appliances is that, in the days of the mainframe, many people were served by one computer. The desktop computer brought the ratio to 1:1. The personal information appliances of R2K will bring multiple computers into the service of each individual -- a complete reversal of the old paradigm.

What will these new devices look like? Some will resemble current devices like the Palm Pilot. Others may just be built into key chains, like the Factoid device designed at Compaq's Western Research Laboratory. This key chain-sized device has the capacity to exchange information with similar devices. It has no buttons, no display, no microphone, and no speaker. Its only I/O device is a 900 MHz transceiver with a range of 30 feet. How would this device be used? Imagine attending a conference and, each time you shake hands with someone, their business card data is transferred to your Factoid, and your information is sent to the other person. When you get back to your office, your Factoid will automatically update your contact manager. The entire process is automatic. Because this PDA has no display or keyboard, there is no user interface to deal with. It operates by itself in the background. As long as these devices can share information with each other and with our other computer systems, there is little question that these devices will proliferate.

For those devices that need to communicate directly with us, earpieces and retinal projection displays can reduce much of the bulk associated with

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computer output devices. While speech recognition still has a long way to go, we are approaching the time when speaker-dependent automatic speech recognition is good enough for many tasks, thus eliminating the need for a keyboard. For a prototype of this form of PDA, look at the cell phones that use inconspicuous headsets. For certain types of information retrieval, a cell phone connected to Portico or MyTalk can already replace some tasks that used to require a computer connected to the Web.

Shift Control...

One of the greatest changes that will bloom during R2K can be expressed in two words found on any computer keyboard: Shift Control. There is a shift in control taking place on many fronts, all facilitated by the technologies of the past fifty years. Because (through the Web) the general public now has access to information that was only available to restricted audiences, people are taking control of their transactions in many powerful ways. Medical doctors have observed that many of their patients are asking more intelligent questions about their treatment based on research done using the plethora of medical information sites on the Web. Car dealers are finding that customers know exactly what the dealer margin is, and are able to drive harder bargains than ever before. Traditional stock brokerage houses are losing customers not just because on-line brokers are cheaper, but because research on stocks can be conducted over the Web for free.

When Francis Bacon said, "Knowledge is power," he meant that the power was held by those who kept the knowledge to themselves. In his essay on Empire he wrote: "And certain it is, that nothing destroyeth authority so much as the unequal and untimely interchange of power pressed too far, and relaxed too much." In the past, consumers had less information than suppliers, and hence had less power in negotiations. Today control has shifted, and successful companies are taking advantage of this phenomenon. Customers are seen not just as consumers, but as producers as well. For example, customers at Amazon.com are allowed to write and post reviews of books they have read, making them contributors to the Amazon site. Software companies commonly make early releases of their software available for free so potential customers can evaluate the features and make recommendations that will improve the final product. Everyone wins in this environment.

Contrast this model of business with the one found in the pre-internet world. Companies created products that were then pushed through the sales channel

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by advertising, pricing, and some measure of luck. Customer involvement in product specification was either non-existent or was limited to small focus groups that were convened to fine tune products once they were fairly far along. The information revolution that preceded R2K set the stage for the rise of the "prosumer," the customer who also influences the production of the item being purchased. Sometimes this relationship appears in the form of mass-customization, (as with Dell, Cisco and other on-line technology vendors). Sometimes it shows up as disintermediation (as with stock brokerage houses or car dealerships), and other times it shows up when a vendor forms an affinity relationship with customers by providing them with a forum for expressing their ideas and sharing them with other customers (as with Amazon).

Whatever form it takes, "shift control" is a dominant force for R2K and it will reach into virtually all transactions.

Education in R2K...

Educational systems have generally mirrored the societies in which they were developed. The shift from the scribal to typographic era, for example, meant that educators' role changed markedly. In the scribal era, lecturers were hired for their capacity to read clearly so students could transcribe their own books directly from the lectures. Once textbooks were mass-produced, the role of educators changed to being content experts who could use the text as one tool to help students achieve mastery in a subject. More recently, education underwent another revolution in response to the needs of the Industrial age. Concepts borrowed from industry and mass-production were mirrored in classrooms as schools restructured around the idea of fixed-length periods, bells, students clustered by age, and subjects taught as if they were piecework. The rise of Taylorism in industry was reflected in the desire of schools to measure student performance through standardized tests.

The impact of this transformation was so strong that it remained virtually intact during the shift from the Industrial to the Information Age. Rather than result in a wholesale transformation of education, the tools of the Information Age were used to improve the productivity of the Industrial Age classrooms without taking advantage of the opportunity to completely overhaul the educational system in response to a new societal paradigm. In retrospect this is not surprising, since society at large was not transformed by the fruits of the Information era until fairly recently. Large corporations generally incorporated the new tools into their old business practices and,

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until recently, did fairly well. It is only with the rapid growth of the Internet that we have seen the world of large existing corporations threatened with oblivion. So, in fact, our educational system has mirrored the world outside classrooms until fairly recently. But, just as corporations are scrambling to reinvent themselves in the face of the information explosion, the shift in control, and the other factors mentioned above, schools will reinvent themselves as well.

The opportunity for schools in R2K is profound. Just as the original Renaissance was about information and creativity, so will this one be. The mark of an educated person during the Renaissance was his or her capacity to think intelligently about a wide range of topics. Beyond that, Renaissance thinkers were creative people, not just those who memorized a large number of disconnected facts. They also thought in terms of projects, not in terms of isolated tasks. The holistic approach to learning in the Renaissance takes on new power during R2K, and forms a foundation for a complete overhaul of educational practice in our schools today.

Fortunately, we have some excellent models in place to launch us into this new era. Chief among them is project-based learning in which mastery of subjects takes place in an interdisciplinary setting while students are engaged in a large project. Examples can be found in both the private and public sector. For example, the Mars Millennium Project co-sponsored by NASA, The U. S. Department of Education, and others, provides a complete interdisciplinary curriculum the cuts across numerous traditional subject area boundaries (science, math, social studies, music, art, etc.) as students engage in a long-term project to design a sustainable community on Mars for the year 2030. Classroom Connect, through its "quests," makes excellent use of the Web as a tool for in-depth interdisciplinary explorations of research projects in which students interact with professionals in the field.

Thus far, the largest long-term project-based learning activity in the world was probably the Brazilian History project lead by ARS in Recife, Brazil. This project (to be completed in 2000) involves up to 15,000 students throughout the country who are spending five years studying Brazilian history (one century per year) through a telematic-based multidisciplinary project that includes field trips during the winter break to historical sites. Students conduct interviews, visit historical locations, create Web sites based on their findings, and post corrections to errors they find in the current history textbooks. Students take part in historical re-enactments and spend an incredible amount of time on their projects. The key to the success of this, or

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any other project-based learning activity, is that it engages student interest. Because project-based learning involves long-term commitment to an activity, it is essential that the underlying topic be engaging to student interests.

The net result of the shift to a project-based curriculum is the death of education as "trivial pursuit." The day may soon come when we look at reruns of Jeopardy and laugh at the idea that we ever thought that intelligence was related to one's capacity to memorize decontextualized tidbits of information.

The beauty of a project-based curriculum is that learning is contextual, and therefore more likely to be retained. While standardized tests will be around for awhile longer, practitioners of a project-based curriculum need not fear for their students. Their performance on tests driven by the Industrial Age paradigm should be just as good as ever, if not better. Of course, new contextual assessments will be developed, probably incorporating peer review of completed projects.

As project-based learning becomes the norm, it will start to have an impact on the transformation of schools from rooms full of students to the creation of learning communities in which teachers and students alike explore domains of inquiry in depth with a balance of information and creativity. The role of technology in this setting can be profound, especially as compact telematic tools become commonplace. Learners and educators will have instant access to informational resources throughout the world. Classrooms will be defined by the presence of learners, not by the rigid structure of schools. Clicks and mortar will co-exist -- learning is a social phenomenon, and communities of learners need to congregate. But they also will have access to informational resources scattered throughout the solar system. In this regard, the impact of R2K on education is likely to be greater than that of the first Renaissance.

Most importantly, students will engage their minds fully in the educational process, not only gaining mastery of the information they need, but exercising their creativity in ways that keep open the doors for lifelong learning.

R2K in the developing world...

As we make the shift to the creative era associated with R2K, global power shifts can emerge. While it is true that the developed world has a strong lead

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in broadband telecommunications, it is also the case that much of the developing world is catching up quickly. A few years ago the Internet backbone for Brazil operated at 10 megabits/sec. Today electric utilities, TV cable operators and telephone companies are racing to bring broadband services to a wide audience at low cost. By 1999 residential customers in Recife, for example, could get broadband (2 Mb/sec) access through fiber optics for about US$20 per month -- a better price than is currently offered in the United States.

The rapid deployment of both fiber and wireless systems is bringing access to the Internet to an ever-increasing audience -- an audience for whom pent-up demand is incredible. Within the next three years, many developing nations will have information access rivaling that of the United States, and some may even approach that offered in Finland -- currently the most-wired country on the planet.

Anyone who has spent time working in the developing world has noticed the tremendous creativity of the people who live there. Because creativity is the currency of R2K, this feature, coupled with the benefits of the telematic revolution, will allow some countries to leapfrog their way into a position of tremendous economic strength. Because of this, anyone who plans to thrive in the coming years should be paying extremely close attention to the developing world, and be prepared to make whatever investments are necessary to take part as R2K becomes a truly global phenomenon.

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The Secretary's Conference on Educational Technology

MEASURING IMPACTS AND SHAPING THE FUTURE

Introduction

"How should the value of technology to learning be measured?"

The Secretary's Conference on Educational Technology 2000: Measuring the Impacts and Shaping the Future highlighted a growing sophistication in K-12 schools' use of technology for teaching and learning.

The 1999 Secretary's Conference on Educational Technology: Evaluating the Effectiveness of Technology acknowledged the quandary before school boards across the country--could it be shown that technology works, that it is making a difference in children's learning? While the press reported that over $7 billion was spent annually on technology in schools, educators were finding it a challenge to document results.

The topic resonated with educators across the country; they attended the conference in record numbers. In many ways, that first conference focused on a crossroads in which to bring together disparate groups--researchers, the evaluators, and the practitioners--to begin the conversation around this important topic.

That first conference established several precedents--it convened the right people around the right topic, in an atmosphere charged with urgency (see). Designed to engage participants in dialogue, it resulted in three advances: new insight into the right questions to be asking, dawning recognition of the team of players required to answer them, and the acknowledgment of the importance of--and lack of progress in--this arena. Important conversations were held at that conference, and while participants left with more questions than answers, they left with a deeper understanding of the complexity of the issue. Many left as members of virtual teams--charging forth to put collective will and wisdom to the pressing questions raised.

In September of 2000, the second national conference was convened to sustain the momentum generated by the first. Today, the nation is more determined than ever to demand accountability from education--and technology is a big-ticket item for most schools and for the nation.

"Can new assessment tools based on emerging technologies provide deeper insight into what a child is learning and how that child's learning might improve?"

The conference program was designed to build on the question set to the left and the commissioned white papers--engaging participants in facilitated breakout sessions informed by provocative plenary speakers, spotlight schools and exhibitors.

Question 1: What constitutes the effective use of technology in learning? What value does technology bring to learning?

The Critical Questions:

What constitutes the effective use of technology in learning? What value does technology bring to learning?

Will we recognize effective uses of technology when we see them?

What uses of learning technology does the public value?

What conditions must be in place in schools to ensure effective technology use?

How can we successfully gauge and report progress with technology at the educator proficiency and system-capacity levels, as well as at the student performance level?

What is the policy roadmap that would build the capacity of communities and schools to move toward more effective uses of technology in schools?

What can we learn from business and

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industry?

A publication referenced by many speakers during the course of the conference was How People Learn: Brain, Mind, Experience and School, a 1999 report by the Committee on the Development of Learning Sciences for the Commission on Behavioral and Social Sciences. The book describes effective learning environments as the integration of four dimensions: learner centered, knowledge-centered, community-centered, and assessment-centered.

"Recent neurocognitive research suggests that the richness of early learning experiences affects the physical development of the brain and may be a major cause of intellectual development."
-Margaret Riel, Associate Director of the Center for Collaborative Education (CCRE)

"Real life learning is often characterized as playful, recursive and non-linear, engaging, self-directed, and meaningful from the learner's perspective. Motivation and learning look like the natural processes they are in real life learning - but they rarely seem so in most school settings."
-Barbara McCombs, Director of the Center for Human Motivation, Learning and Development

"Studies did find improvements in student scores on tests closely related to material covered in computer-assisted instructional packages (Kulik & Kulik, 1991)."
-Quoted by Margaret Honey, Director of CCT

"What it means to be educated for today's digital age is decidedly different from what it was just a decade ago. To succeed today, students need collaboration, online communication, visualization, information literacy, and lifelong learning--twenty-first century--skills."
-Cheryl Lemke, Metiri Group

"Research has demonstrated that authentic tasks with real audiences have resulted in increased learning, stronger writing, longer retention of learning and even increased performance on standardized tests of writing."
-Margaret Riel, Associate Director of the Center for Collaborative Education (CCRE)

Conference participants, cognizant of the need for integrated learning environments and the multiple ways in which technology enables educators to create such environments, drew the following conclusions:

- *Breakthroughs in technology have advanced what is known about how children think and learn.*
- *Research shows that, under the right conditions, technology advances children's academic achievement.*
- *Technology's tremendous influence on society has changed what children need to know and be able to do to be successful today*
- *Emerging technologies can and should be used to more accurately assess what and why children are or are not learning.*

The four concepts use technology to do things differently, just as they use technology to do different things. As with all technological advances, schools' transition from the old to the new is not without its challenges. Each of the four ways in which technology adds value is discussed in more depth in the following paragraphs.

- *Breakthroughs in technology have advanced what is known about how children think and learn.*

- *Research shows that, under the right conditions, technology advances children's academic achievement.* The context in which technology is used is key to its effectiveness. While the use of technology in schools is still in its infancy, enough exploration has occurred to warrant serious research and development to document research findings and best practices.
- *Technology's tremendous influence on society has changed what children need to know and be able to do to be successful today.* Technology has caused tremendous shifts in today's society--economic, political, social, and civic. Acknowledgment of these shifts changes the question before schools from "if" technology belongs in schools to "what" constitutes an excellent education in this digital age, and "how" schools use technology effectively to advance student learning.

- *Emerging technologies should be used to more accurately assess what and why children are (or are not) learning--and how technology can help.* Even as teachers are beginning to engage their students in more hands-on discovery, they lack the skills to fully capture what students are learning. In

"Profound learning happens when models student build to simulate reality meet data students collect. The combination of sophisticated data acquisition from probes and Internet databases with models that can be compared to data, can lead to breakthroughs."
-Robert Tinker, Concord Consortium

"Rather than assessing the benefits of technology, the focus of technology assessment will be to explore how to enhance those benefits by matching them to learner needs combined with information on how learning best occurs."
-Barbara McCombs, Center for Human Motivation, Learning, and Development

"Technology can make assessments of the kinds of skills needed for the 21st century knowledge economy more feasible--providing assessment tasks that mimic the features of real-world problems and providing portable, easy-to-use templates for collecting and storing classroom assessment data."
-Barbara Means, Bill Penuel and Edys Quellmalz, SRI International

Story: Understanding the World with Technology

Imagine 1st and 2nd graders tapping into I*EARN to learn to read, explore mathematics, travel (virtually) around the world, and discover other cultures. The children in Kristi Rennebohm Franz's classroom in Pullman, Washington are innately using language to make sense of their world, to launch their literacy, and to communicate their essential learning (content standards in Washington State).

Story: Hands-On Learning

In an inner-city high school physics class in Chicago, students are examining computer images captured by automated telescopes. Developed at UC Berkeley's Lawrence Berkeley Lab with support from TERC, the Hands-on

fact, students see the inquiry-based aspects of learning as fun--but not serious learning--since their grades reflect only standardized tests based on the textbook with no recognition of what they might have learned in field experiments.

The North Central Regional Educational Laboratory has recently launched their enGauge website with a new list of 21st century skills:

21st Century Skills © NCREL

Digital Age Literacy

- Basic, Scientific, and Technological Literacy
- Visual and information Literacy
- Cultural Literacy and Global Awareness

Inventive Thinking

- Adaptability/Managing Complexity
- Curiosity, Creativity, and Risk Taking
- Higher Order Thinking and Sound Reasoning

Effective Communication

- Teaming, Collaboration, and Interpersonal Skills
- Personal and Social Responsibility
- Interactive Communication

High Productivity

- Prioritizing, Planning, and Managing for Results
- Effective Use of Real-World Tools
- Relevant, High Quality Products

Participants in the breakout groups at the conference emphasized the importance of these skills--and expressed frustration that, while 21st century skills should be included in today's curriculum, high stakes testing was a huge deterrent from doing so (see the discussion below).

"Technology prompts a higher level of engagement of students in the classroom."
-Participant Comment on ***Engagement***

"Technology adds a component of collaboration where learning is not contrived."
-Participant Comment on ***Collaboration***

"Technology enables us to be more learner-centered. It reaches all kids--technology can even out the differences."
-Participant Comment on ***Individualization***

"These are skills students will need to get a job--and be successful in the world of work."
-Participant Comment on ***Real-World Skills***

Universe project involves students in reviewing images from space. Two Hands-on Universe student groups have in fact discovered previously unknown super novas and had their work published in scientific journals. The kinds of complex investigations, deeper understanding, and ability to apply concepts to new situations fostered by technology-supported programs like Hands-on Universe are difficult to capture with conventional test formats.

"Students and teachers both have access to information that they couldn't get from the library."
-Participant Comment on ***New Access to Information***

"They (students) need to be able to use technology to solve problems--real-world problems."
-Participant Comment on ***Thinking Skills***

Question #2: Will we recognize effective uses of technology when we see them?

The above question is deceptively simple. According to the conference participants:

- The indicators of effective uses have yet to be determined
- Schools are struggling to find common ground between the traditional and the new
- Schools need to become high performance, high technology systems

Five key ways in which technology adds to learning:

- Real world contexts
- Connections to outside experts
- Visualization and analysis tools
- Scaffolds for problem solving
- Opportunities for feedback, reflection, and revision.

-From "How People Learn," John Bransford et al, as quoted by Barbara Means, SRI

SCANS Three-Part Foundation:

1. *Basic Skills:* Reading, writing, arithmetic, listening, speaking
2. *Thinking Skills:* Creative thinking, decision making, problem solving, seeing things in the mind's eye, knowing how to learn, reasoning
3. *Personal Qualities:* Responsibility, self-esteem, sociability, self-management, integrity

"...Teachers may feel anxious about devoting precious instructional minutes to technology-based activities that are not preparing students to do well on mandated multiple-choice tests."
-Barbara Means, Bill Penuel and Edys Quellmalz, SRI International

"Students who use computers regularly see measurable improvements in the quality of their writing...[but] recent research shows that paper and pencil tests severely underestimate the

The indicators of effective uses have yet to be determined. There is a growing sentiment that the assessment of the impact of technology on learning involves more than just a look at changes in test scores--unless those test scores reflect the 21st century skills students need to succeed today. Content standards are still important, but they are no longer (if ever they did) represent the full profile of what students need to know and be able to do to succeed in a digital age.

The Secretary's Commission on Achieving Necessary Skills (SCANS) was appointed by the U.S. Secretary of Labor to outline the skills students need to succeed in the working world. As outlined in the report, high-performance learning organizations require workers who are well grounded in:

- Basic literacy and computational skills
- The thinking skills necessary to put knowledge into practice
- Personal qualities that demonstrate dependability, sociability, self-management, and honesty

Schools are struggling to find common ground between the traditional and the new. On the one hand, they acknowledge the necessity of immersing students in learning within the context of contemporary technology tools. On the other, most current assessments do not address 21st century skills--and thus provide disincentives to teachers devoting learning time toward that end.

Schools need to become high performance, high technology systems. In order to use technology effectively, the school has to evolve into a learning system that embraces the effective use of technology. That translates into learning cultures that are open to innovation--systems that judge the merit of an idea not by its fit with rules and regulations, but its usefulness to advancing the mission of schools, learning.

achievement of students accustomed to writing on computers."
-Michael Russell, Center for the Study of Testing, Evaluation, and Education Policy

"Technology can make assessments of the kinds of skills needed for the 21st century knowledge economy more feasible--providing assessment tasks that mimic the features of real-world problems"
-Barbara Means, Bill Penuel and Edys Quellmalz, SRI International

Four technology and assessment projects launched at the 1999 Conference were back this year to report their progress:

- *Mantua Elementary School, Fairfax Co., VA*
- *Snapshot Service, a cooperative between University of Michigan and the University of Texas*
- *Montgomery County Public Schools, MD*

  Reports for the above three projects are available online.
- *Cherry Creek School District, Colorado, in partnership with CRESST, UCLA*

Question #3: What uses of learning technology does the public value?

"Currently, report cards are the most important reporting program. If a report card states that math, reading, science, music, etc. are the areas of focus and emphasis, versus a focus on critical learning, problem solving, etc., when report cards go home the parent thinks math, science, etc. is the most important learned skill. We need to make a paradigm shift. How do you translate student problem solving skills into the report card at the end of the term?"
-Conference Participant

Margaret Riel set the stage for this answer in her white paper. "Educational goals are tied to learning environments; as one changes so must the other. Literacy goals 100 years ago for many students were to be able to read and write names, copy and read texts, and generate lists of merchandise. Literacy goals of today require mastery over many different genres of writing: persuasive, expressive, expository, procedural and expect students to be able to interpret, compare, contrast, and analyze complex texts. These differences in learning goals also hold for mathematics. Students learn the mathematical foundations necessary for careers that did not exist 100 years ago. There has been exponential growth in the amount of recorded knowledge so that memorization of factual information is no longer an effective approach to mastery of a field."

Even as participants at this conference were espousing the importance of the 21st century skills listed above, they were at the same time lamenting the fact that the public has not fully embraced those skills as being as important as reading, writing, science, and mathematics. In part, it is the responsibility of educators to educate and inform the public as to what should be emphasized in schools.

Question #4: What conditions must be in place in schools to ensure effective technology use?

Participants had much to say on this topic. In particular:

- School culture must change
- Vision, Communication, Leadership, Community Connections, and Assessment are the top five Conditions for effective use
- Equitable Access and Teacher Proficiency are also important
- There are significant barriers to effective uses of technology

"We need to change the culture. Teaching needs to become a profession."
-Lynn Schrum, Conference Participant, University of Georgia

"We need an enabling and capacity-building culture...[that is] learner-driven and research-based."
-Cheryl Lemke, Metiri Group

"If teachers can see how technology impacts what they teach and are provided with the right tools, they will use the technology."
-Conference Participant

"To move toward this vision will require new concepts defining the learning process and the evolving purpose of education. It will also require rethinking current directions and practices."
-Barbara McCombs, Director of the Center for Human Motivation, Learning and Development

"It's not so much proving that we're doing something as having good communication and filling up the screens with the kinds of benefits and results that the community says 'that's worth the money.'"
- Bernajean Porter, Education Technology Planners

"We can ask administrators to create environments where technology can be used for learning, as well as for teaching, and where both learners and teachers have sufficient access to computers and telecommunications to do their work."
-Saul Rockman, Rockman et al

"Education is a human enterprise. It is dependent on the relationship between teachers and learners in a specific social, political, and historical context."
-Margaret Riel, Associate Director of the Center for Collaborative Education (CCRE)

"[We should be focused on] building heterogeneous groups of individuals who are all looking at the same kind of project but who bring different skills to the mix."

School culture must change. If students and teachers are to take full advantage of what technology makes possible in teaching and learning, schools must change. They must become more student-centered, more focused on 21st century skills, more open to innovation through technology, more willing to fully support and grow the infrastructure they install, and they must be lead by educators who recognize the critical role technology plays in defining an excellent education in this digital age. This won't happen without changes in the K-12 assessment.

Vision, Communication, Leadership, Community Connections, and Assessment are the top five Conditions for effective use (as reported by conference participants):

1. *Shared Vision* is:
    - Well-defined
    - Research-based
    - Consistent
    - Motivating

    and involves:

    - All stakeholders
    - Trust
    - A plan for ongoing funding, equipment and training updates
2. *Communication among all stakeholders* is:
    - Regular and ongoing
    - Based on shared goals
    - Technology-based

    and provides for:

    - Feedback on what works/what doesn't
    - Opportunities to share progress
3. *Leadership* is.
    - Strong
    - Supported by the vision
    - Ongoing
    - Motivating

    and it:

    - Facilitates change
    - Makes curricular and instructional connections explicit
    - Engages other staff and community members

    Recognizes the ongoing need for meaningful professional development among all staff
4. *Community Connections* are:
    - Local
    - Regional

*-Jim Nazworthy, High Plains R*TEC*

"The personal connections are very important. It's not just about the technology. In fact, it's not about the technology at all; it's about hooking up people to concentrate on common problems or cases."
-Robert McNergney, University of Virginia

"One major advantage of embedding assessment within learning activities is the heightened focus on learning outcomes...Teachers must think about the kinds of skills and knowledge they are trying to impart through learning activities, and this reflection in turn supports better activity design and better articulation of learning goals to students."
-Barbara Means, Bill Penuel and Edys Quellmalz, SRI International

"The vanishing of the digital divide defined as access to technology in the US will not, of course, rectify the deplorable inequities in US schools."
-Robert Tinker, Concord Consortium

Think Box: Literacy Equity

"...Technology will greatly reduce the amount of teacher time required for literacy instruction...resulting in huge technology breakthroughs. This could result in literacy gains worldwide, while decreasing the advantage families have that can find the time to read to their children extensively."
-Robert Tinker, Concord Consortium

"Teaching is an emergent, interactive constructed activity that requires a complex blend of knowledge of the students and knowledge of the curriculum."
-Margaret Riel, Associate Director of the Center for Collaborative Education (CCRE)

"While much of the funding for the e-rate has gone to high poverty schools, the poorest of the poor are not yet benefiting as much as they should."
-Former Secretary of Education Richard Riley

- Global
- Mutually beneficial
- Formal
- Technology-supported
- Ongoing

5. *Assessments* are:

- New
- Clear
- Aligned to digital age content standards
- Technology-based
- Focused on learning outcomes

Equitable Access and Teacher Proficiency are also important. Two additional essential conditions must be in place to facilitate effective use of technology as well: equitable, robust access and educator proficiency.

- *Equity is more than access.* A first step toward equity is equal access to up-to-date equipment and high-speed access to the Internet, both during and outside the school day and in all schools. Nevertheless, such access, while critically important, is only as good as the students' ability to use it toward meaningful goals.
- *Teacher proficiency is key.* Educators are waking up to the fact that this movement is not about technology--this is about extending children's intellectual capacity through the use of contemporary tools. It is up to teachers to create the powerful learning situations where technology can enrich and extend the experience of students.

There are significant barriers to effective uses of technology. The most serious Barriers to significant, effective uses of technology for learning (as reported by participants) are:

Age of:

- Equipment
- Wiring
- Facilities
- Attitudes

Lack of:

- Ongoing support
- Communication
- Training for technical skill and implementation
- Active leadership
- Accountability/benchmarks
- Vision and clear goals
- Equipment

"There appears to be a policy disconnect between those who fund technology and establish rules and regulations for its use, and those who actually work in the districts and schools and classrooms."
-Saul Rockman, Rockman et al

"Lacking familiarity with ways to test deeper understandings or higher-order skills...teachers often implement [an] activity without assessing what students are learning from it."
-Barbara Means, Bill Penuel and Edys Quellmalz, SRI International

"We are hitting the same group of teachers every time. I need to know how to reach the next group, the non-innovators."
-Conference Participant

- Funding
- Clear expectations
- Creative, alternative curricular solutions
- New certification requirement

School Culture:

- Isolation
- Reluctance to change (further hindered by union contracts)
- Time/scheduling inflexibility

Voters and Policymakers:

- Public resistance and fear
- Lack of knowledge
- Resistance to funding measures
- Lack of accountability
- Expectation of short-term returns

Question #5: How can we successfully gauge and report progress with technology at the educator proficiency and system-capacity levels, as well as at the student performance level?

Conference participants and presenters alike cited the need for more work in this critical area

- New ways of assessing and reporting progress are needed
- New evaluation tools are needed
- More work is needed

"The question is: Can we work smarter, not harder? What does it really take to build the capacity of our system?"
-Cheryl Lemke, Metiri Group

"People are being assessed on technology using paper and pencil, multiple choice tests."
-Karen Brumley, Conference Participant and teacher: Pickerington Junior High School, Pickerington OH

"Until tests that measure the types of learning enabled by computers are developed, it is likely that the public and policymakers will undervalue the types of learning influenced by computers. In turn, the public and policymakers will continue to underestimate the impact computers have on student learning."
-Michael Russell, Center for the Study of Testing, Evaluation, and Education Policy

EnGauge, presented by Cheryl Lemke, Metiri

New ways of assessing and reporting progress are needed. Despite advances made in the effective integration of technology into instructional settings, a key barrier remains: the need for a quality gauge of student, educator, and systems progress.

Barbara Reeves, state technology director in Maryland, spoke on two key elements to school reform efforts:

Accountability: "setting very specific standards and targets and measuring progress toward those targets...also making our progress very visible."

and

Data-driven decision-making: "using the data we're collecting to make key decisions, all the way from the shape of instructional programs in a classroom or school [to] the forming of state budgets."

New evaluation tools are needed. On day one of the conference, Margaret Honey, Director of the Center for Children and Technology, moderated a panel of experts who discussed several evaluation tools for educators. Developed by both for-profit and not-for-profit groups, as well as a consortium of business and industry leaders,

Group

Four Cornerstones, presented by Bernajean Porter, Education Technology Planners

Profiler, presented by Jim Nazworthy, High Plains R*TEC

CEO Forum STaR Chart, presented by Cheryl Williams, National School Board Association

SEIR*TEC, SouthEast and Islands Regional Technology in Education Consortium

these tools are designed to help schools:

- Cooperate and collaborate
- Share expertise and assistance
- Use technology effectively for teaching, learning and managing
- Assess and track their progress in relation to established, research-based benchmarks.

More work is needed. Educators, researchers, business leaders, and other stakeholders are working hard to develop comprehensive ways to gauge and report progress on all three levels. More work is needed and many questions remain unanswered. Conference participants took a major step by delving into these questions and the complex issues behind them, but the process is ongoing.

Question #6: What is the policy roadmap that would build the capacity of communities and schools to move toward more effective uses of technology in schools?

"We often talk about school board members and other policymakers as them and us. They are us, and we need to educate them. They are not the enemy."
-Conference Participant

"Thirty second sound bites aren't really improving the discourse on education."
-Conference Participant

"Schools need to undertake major changes to fully exploit technology."
-Robert Tinker, Concord Consortium

"While these assessment prototypes are still under development, they do offer illustrations of the way that technology can make classroom assessment of complex skills more feasible."
-Barbara Means, Bill Penuel, Edys Quellmalz, SRI International

"More recent research, however, shows that young people who are accustomed to writing with computers perform significantly worse on open-ended questions (that is, not multiple choice) questions administered on paper as compared with the same questions administered via computer (Russell & Haney, 1997; Russell, 1999; Russell & Plati, 2000).

Participants spoke positively about the need to develop deeper relationships with policymakers. There is a prevailing belief that keeping the lines of communication open is the key to satisfying everyone's needs. At the same time, there were two distinct notes of caution sounded. The first is that policymakers should not expect short-term results of incredible magnitude. They must acknowledge that investment in educational technology is an investment in the future. Second, educators and administrators acknowledged that they can and should play a more active and honest role in keeping policymakers informed of real gains.

Participants recommended showcasing student successes directly to board members and other policymakers, going to their offices, inviting them into classrooms, and keeping community and business partners informed at the local level so that knowledge can "move up the system."

They recommended policy actions to enable the education community to:

- *Embrace twenty-first century skills as high stakes learning goals.* What is tested is taught. Once twenty-first century skills are accepted as essential to an excellent education--and associated assessments are developed--educators will begin the serious work of incorporating those skills into academic content and curriculum.

- *Develop new technology-based tools that more accurately assess student learning--including 21st century skills.* Emerging technologies hold great potential for more accurate and efficient

-Michael Russell

The possibilities:

- For teachers:

"The rapid changes in standards, assessment, content, curricula, and educational technologies create a massive need for ongoing professional development. Effective online courses can revolutionize professional development. But a set of economic, political, and practical problems must be solved."

- For the teaching of literacy:

"Technological tools will become increasingly important in teaching literacy and second languages to children, adults, and special students."

- For access to resources:

"The value of a textbook and its ancillary materials is that it represents a coherent aggregation of resources and educational activities. Technology can provide the benefits of aggregation while avoiding the costs, inflexibility of a text and constraints of needing to own all the materials."
-Robert Tinker, Concord Consortium

assessment of what students are learning. With these tools in hand, teachers and students could be more prescriptive and deliberate about what is expected, how much progress is being made, and what course corrections are required along the way to optimize student learning.

- *Develop technology-based assessments addressing twenty-first century skills.* Educators need alignment between the realities of today's knowledge-based digital age, the content standards, and the high-stakes testing in schools. Right now, while their common sense suggests that new 21st century skills--in the context of content standards--should be a focus of learning, in most states high stakes tests don't address such foci, creating a critical disconnect that must be overcome.

- *Establish a base of research and proven practice about technology, children, and learning to inform decision-making.* The rate of change of emerging technologies renders many long-term studies irrelevant by the time they are completed. Education needs new research methods that provide continuous insight and data to guide decision-making about technology in schools.

- *Implement innovative and effective uses of technology for learning.* While many schools are reaching a critical mass of infrastructure, most are not yet using their technology in innovative ways. To do so will require new visions of learning that reflect advances in brain research, cognitive learning theory, and technology. Due in part to the decentralized decision-making in schools for products and services, relatively little money is being invested in the development of innovations that apply emerging technologies to learning and teaching. Yet the possibilities are endless
- *Evolve Schools into High Performance, High Technology Systems.* In order to use technology effectively, the school has to evolve into a learning system that embraces the effective use of technology. That translates into learning cultures that are open to innovation--systems that judge the merit of an idea not by its fit with rules and regulations, but its usefulness to advancing the mission of schools, learning.

Question #7: What can we learn from business and industry?

The 2000 Secretary's Conference provided a forum for shared strategies among both educators and business and industry leaders. The key finding that emerged was:

- There is a growing sense that business models have a lot to offer schools

After all, as one participant put it, *"There are no multiple choice questions in business." -David Polashek, Superintendent, Oconto Falls Public School District, Oconto Falls WI*

"Creativity, being able to stay on task is critical. The state capital of Vermont is not, as long as students know how to get the information when they need it...[When hiring] I want to get a sense of how people think through issues. Imagination is more important than knowledge. So how do you make the connection between the two?" -Jeffrey Orloff, Conference Participant, Apple Computer, Inc.

"[The best community partners] see that it's in their best interest to help strengthen schools and to give frameworks and support for school districts to be able to make change happen." -Cheryl Williams, National School Board Association

Story: Kinko's for Kids

Lorin Somerlot, a teacher at New Albany High School in Ohio, spoke of the success of her school's partnership with a local Kinko's. The copy center, located on the school campus and run as a Kinko's franchise (in partnership with the Columbus Metropolitan Library), is known as Kinko's for Kids. Lorin proudly points out that the center is entirely self-funded. With its many computer workstations, students have ample opportunity to access technology even when they can't at home.

There is a growing sense that business models have a lot to offer schools. Despite differences in culture and patterns of technology use, increasing numbers of school partnerships with businesses have revealed some important common threads. Several of this year's participants mentioned the valuable experience of "being on both sides of the fence," having worked in education and moved to business or vice versa. In addition, business and industry leaders often have a solid sense of critical 21st century skills and can offer educators key connections to the real world environment in which they are used.

Robust and equitable access to technology, conference participants agreed, goes beyond school and district buildings. Many suggested that good business partnerships were necessary for ensuring after-hours access.

According to Eric Benhamou, a keynote speaker from 3Com, educational stakeholders would be wise to mirror industry trends to increase access to technology. Benhamou sees these trends as involving the following:

- From plain to rich connectivity
- From general purpose devices to special purpose devices
- From large enterprises to smaller sites

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